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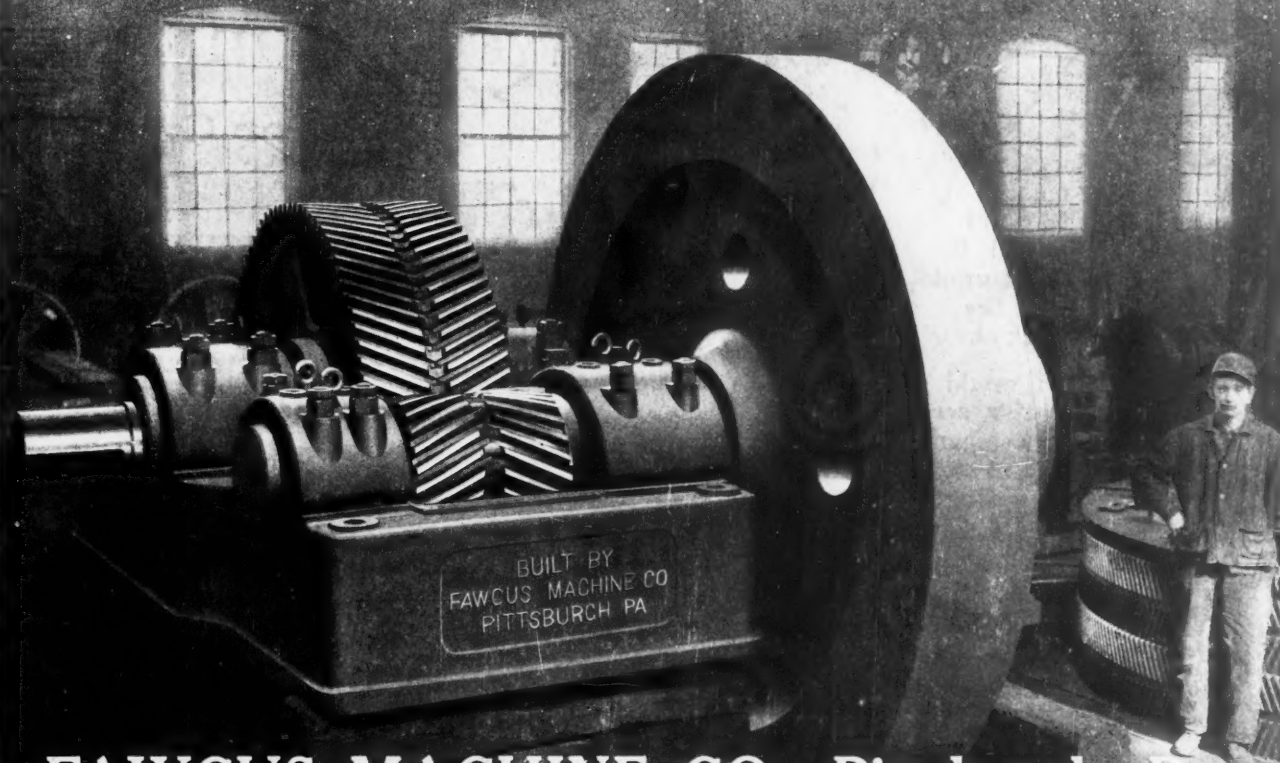
have been designed, consisting of ten sizes of frames to suit gears for ratios 3:1 to 12:1 and to transmit any power up to 1500 H. P. Special designs for loads over 1500 H. P.—with flywheels if necessary.

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FAWCUS MACHINE CO., Pittsburgh, Pa.

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Requires the Use of Pyrometers

The present cost of high-speed steel should mean the greatest care in heat treatment. Guesswork should be eliminated.

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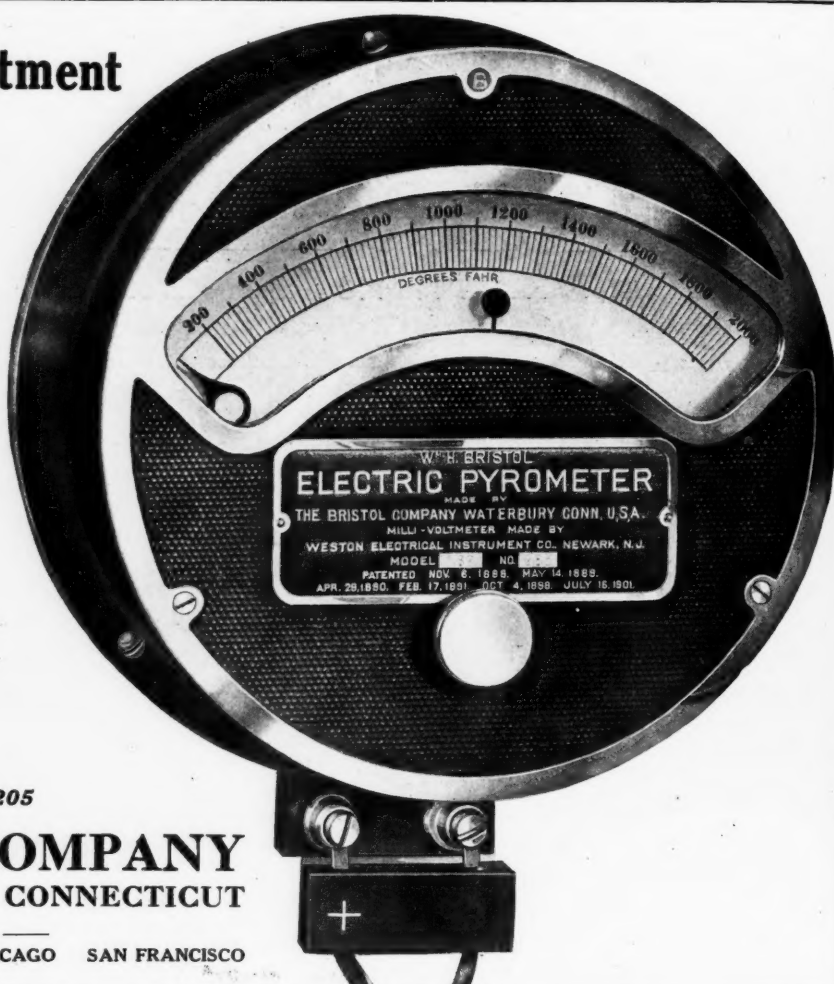
Are dependable and assure accurate results. Simplicity of construction and ruggedness make it an ideal shop pyrometer, and it is the choice of many manufacturers in various industries.

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VANADIUM

PROVES BEST FOR SPRINGS

The Raymond Manufacturing Company, Corry, Pa., the large manufacturers of coil springs, was asked to supply the highest grade springs for one of the leading makes of shock absorbers.

To decide which would give its customer the better service, this company made a comparative test of springs of vanadium steel and another well-known alloy spring steel.

The results were conclusive.

Under the same fibre stress, the vanadium steel springs stood 45% more compressions before breaking. *Let us send you details.*

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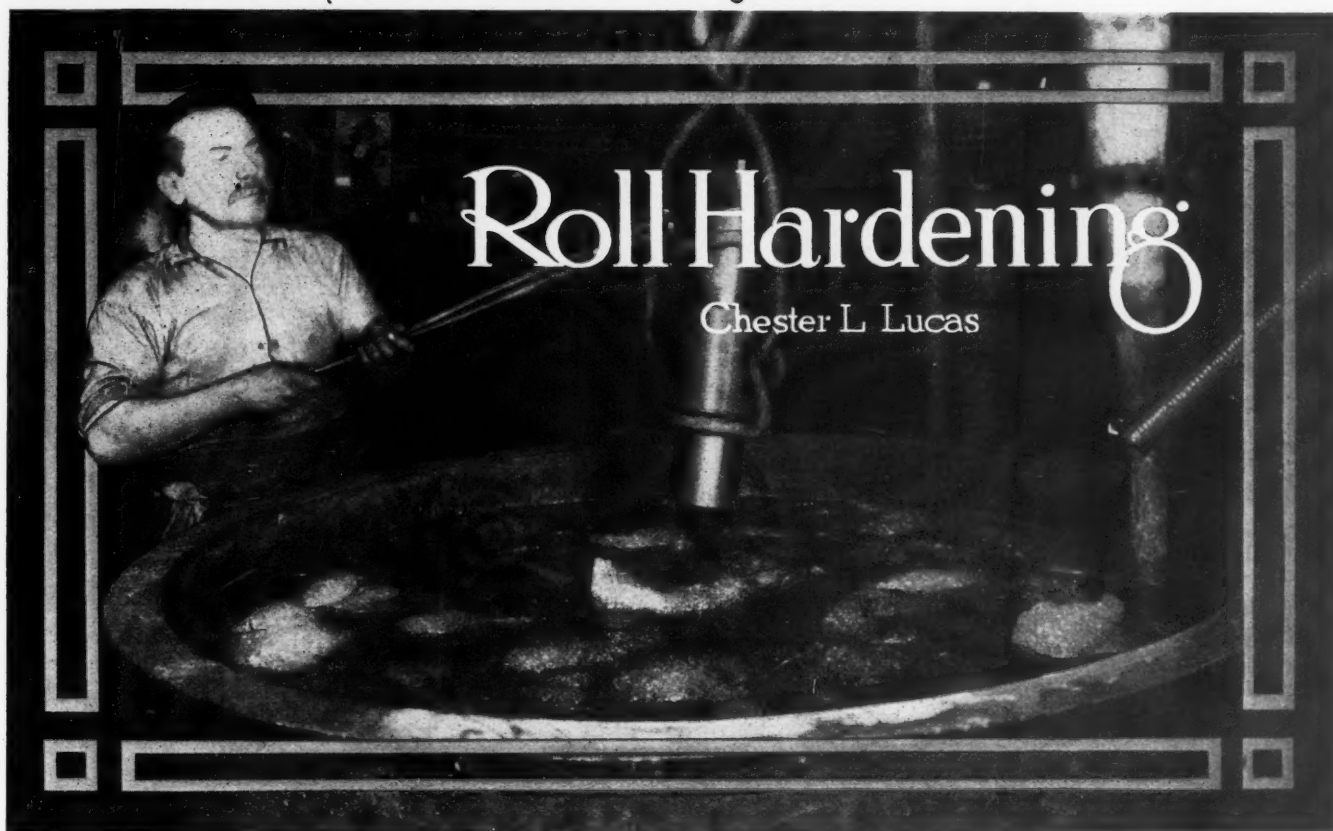
General Offices: Vanadium Bldg., Pittsburgh

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Another Case





THE inspector and the steel hardener travel the same road through life.

When things go right, little attention is paid to them, but as soon as trouble arrives, they are the most unpopular men in the shop. Owing to the variation in steel, the treatments it has undergone and the shapes that must be handled, there is a risk attendant upon any steel hardening operation. In hardening rolls for rolling mill use, the roll must be hardened all over to a great depth; therefore this risk is greatly magnified because the steel must be "forced" to secure this ultra-hard condition. The hardener has always before him the possibility of a soft roll or, worse yet, during the anxious moments when the roll is under water, he may hear that sharp cracking sound that indicates that he has a cracked roll on his hands. The Standard Machinery Co. of Providence, R. I., has been a manufacturer of rolling mills for years, and consequently has made a specialty of roll hardening. Through this company's courtesy the operations connected with roll hardening are here described.

Metal Rolling Machinery

The general subject of metal rolling may be roughly

The hardening of large steel rolls used for metal rolling, especially those required in brass mills, jewelry manufacture and kindred lines, presents one of the most difficult branches of the steel hardener's art. A finished roll often represents a cost of several hundred dollars, and the responsibility resting on the hardener is no small matter. The rolls must be hardened without developing flaws, cracks or soft spots, which means that the roll must be heated evenly and to the proper temperature; when dipped, it must be cooled immediately and uniformly. In order to secure the hardness required, the bath is charged with salt and ice. This article describes the method of heating and quenching, testing for hardness, and the grinding and lapping of the rolls after hardening.

reducing the thickness of sheet steel, brass, copper, gold and silver sheets, the rolls are made of tool steel, hardened and finished to a high degree of accuracy in order that the rolled product may be accurate in thickness and finish.

As it is with the latter class of rolls that this article is to deal, one of these rolling mills, a product of the Standard

divided into two classes: hot rolling and cold rolling. In hot rolling, which is the method used in producing structural iron shapes and other large sections, the rolls used are made of chilled castings. In cold rolling, which is the process employed for

Machinery Co., Providence, R. I., is reproduced in Fig. 4. From this illustration, in conjunction with Fig. 7 which shows a section through the working end of a typical rolling mill, an idea of the way the rolls are supported and driven may be obtained. With this understanding the hardening operation will be better appreciated. The drive of the rolling mill is from a motor beneath the machine, and through a series of reduction gears rotation is transmitted to the lower of the helical gears at the left-hand end of the machine as viewed in Fig. 4. This helical drive smoothly couples the rotation of the two rolls. From the rear end of the machine motion is

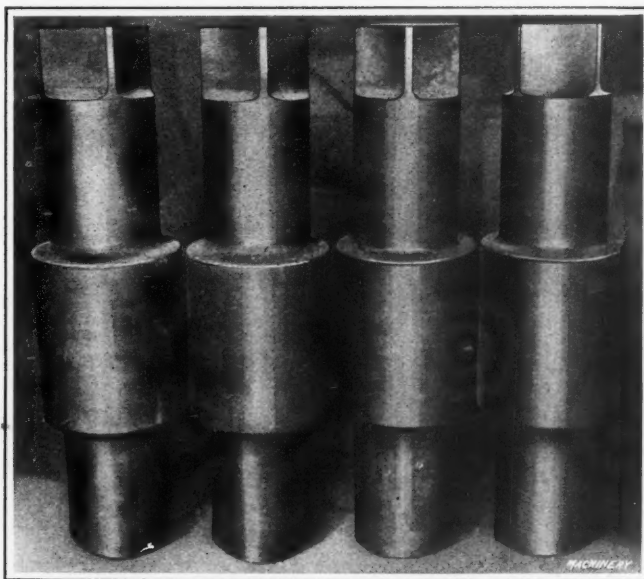


Fig. 1. Two Sets of Rolls ready for hardening



Fig. 2. Packing Roll in Hardening Pot

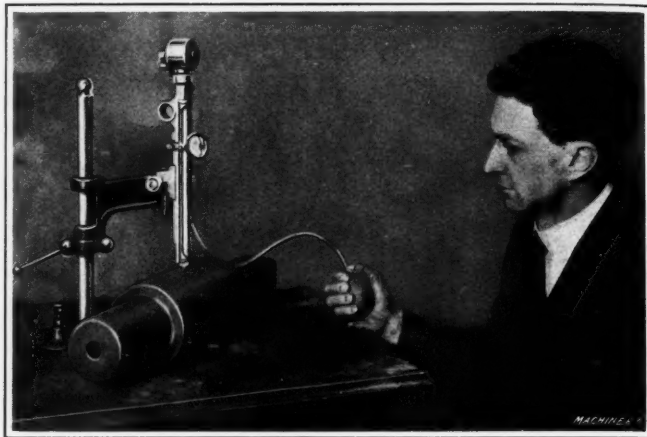


Fig. 3. Testing Hardened Roll with Scleroscope

transmitted to the rolls proper by square bars known as "wabbler" coupling bars. The ends of these bars are loosely fitted in cast couplings that connect the ends of the wabbler bars with the drive at one end and with the rolls at the other. The fit of the couplings is very loose to admit of the vertical adjustment of the rolls in their housings that is necessary to secure varying thicknesses of rolled material. These couplings are made from castings so that, being the weakest members of the drive, they will break before the more expensive parts in case of overload.

The sectional illustration, Fig. 7, is taken through a pair of rolls, 10 inches in diameter by 15 inches long. From the upper part of Fig. 10, which shows this roll in detail, it may be seen that the total length is 37 inches. The journals are 8 inches diameter by $8\frac{1}{2}$ inches long, and the wabbler ends are 5 inches long by 6 inches square.

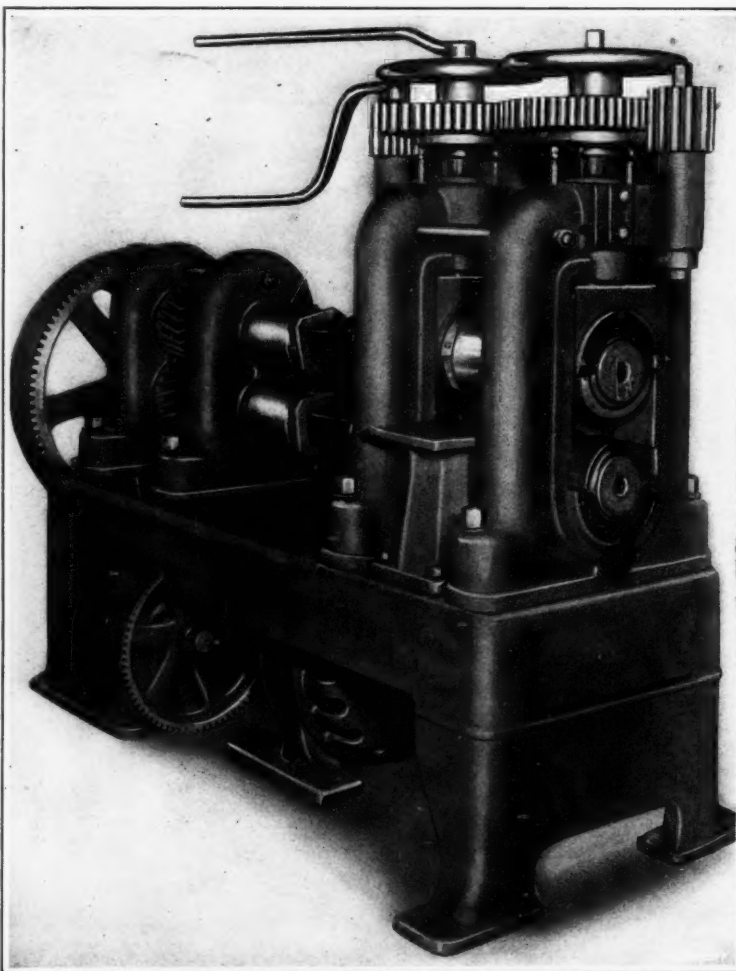


Fig. 4. Standard Machinery Co.'s Rolling Mill

The rolls on Standard Machinery Co.'s rolling mills are mounted in roller bearings, and the roller bearings, in turn, are supported in the housing blocks of the machine. The upper pair of the housing blocks may be raised or lowered to vary the distance between the rolls, thereby governing the thickness of the metal rolled.

Fig. 1 illustrates two pairs of rolls 8 inches in diameter by 10 inches long, and gives a good idea of the proportions of the journals or bearing sections of the roll in comparison with the working surfaces. Fig. 10 gives the actual dimensions of a pair of 10-inch by 15-inch rolls and illustrates different types of wabbler ends that are sometimes employed for driving the rolls instead of the square end. The square wabbler is most commonly used, especially in the smaller sizes of mills, while styles C and D are used in mills having rolls 12 inches in diameter or over.

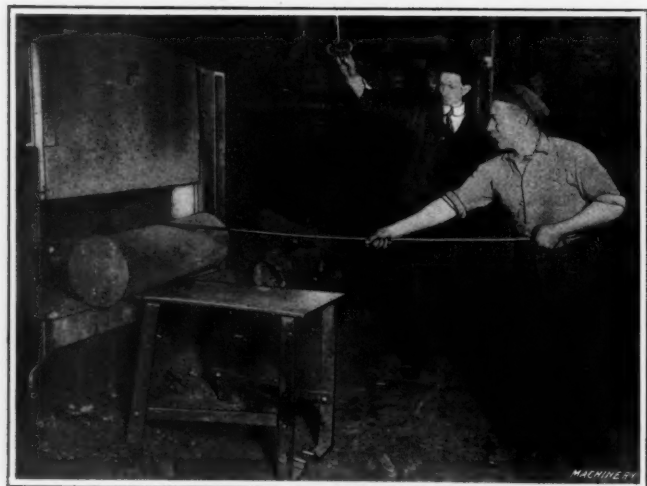


Fig. 5. Starting the Heat

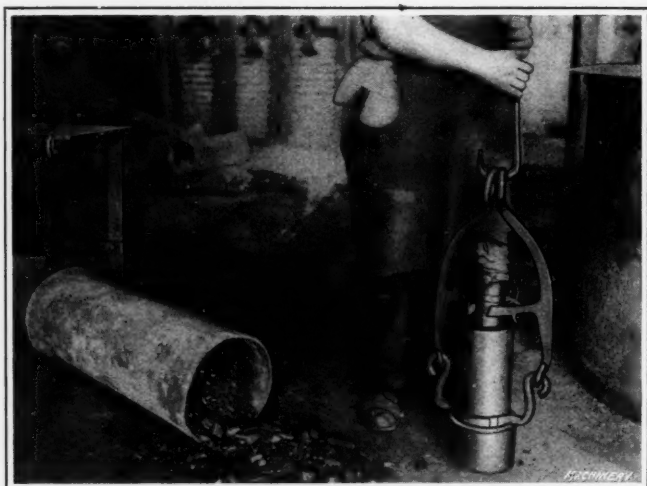


Fig. 6. Putting Roll in Quenching Cradle

Preparing the Rolls

In manufacturing these steel rolls, tool steel of 0.70 to 1.00 per cent carbon is employed. The smaller sizes of rolls are often turned from bar stock, but the larger sizes are first forged to give better structure as well as to save steel. The machining operations on the rolls are not unusual in any way, and consist in turning to within 0.040 to 0.080 inch of the finished size, the amount depending on the size of the roll. The journals are then turned in the same way, and the wabblers ends are milled to the proper shape and size. Before the rolls go into the hardening furnace, they must be prepared by protecting the wabblers ends with fireclay and asbestos, so they will not harden. The fireclay is applied directly to the wabblers and wound in asbestos cloth. Soft iron wire is used to bind the asbestos cloth in place.

As the rolls require heating for from twenty-four to thirty hours according to the size, it is necessary that they be packed in air-tight boxes. Fig. 2 shows how the rolls are packed in charcoal in the heating pots. Several inches of charcoal surround the roll at every point and effectively protect it from oxidizing. Fig. 9 shows how the covers of the pots are luted with fireclay before they go into the furnace.

Heating the Rolls

The heating of the rolls preparatory to hardening is one of the most important steps in the work. The furnaces used are of the oil-burning type, and the front of one of them may be seen in Fig. 5, where the operator is shown charging the furnace. The furnace is brought to a heat of approximately 1000 degrees F. before the roll pots are put in. This temperature is maintained for twelve hours, the pots being frequently turned from time to time to insure an even distribution of heat, and the temperature is then raised to 1500 degrees F. and maintained at this heat for six hours. After this pre-heating, the temperature is raised to 1650 degrees F. and the heating is continued for another six hours, making a total of twenty-four hours that the rolls are under heat. The heats are carefully checked with a pyrometer and every precaution is taken to insure that the rolls are evenly heated.

Quenching the Rolls

The part of the heat-treatment around which everything else centers is, of course, the quenching, and on ac-

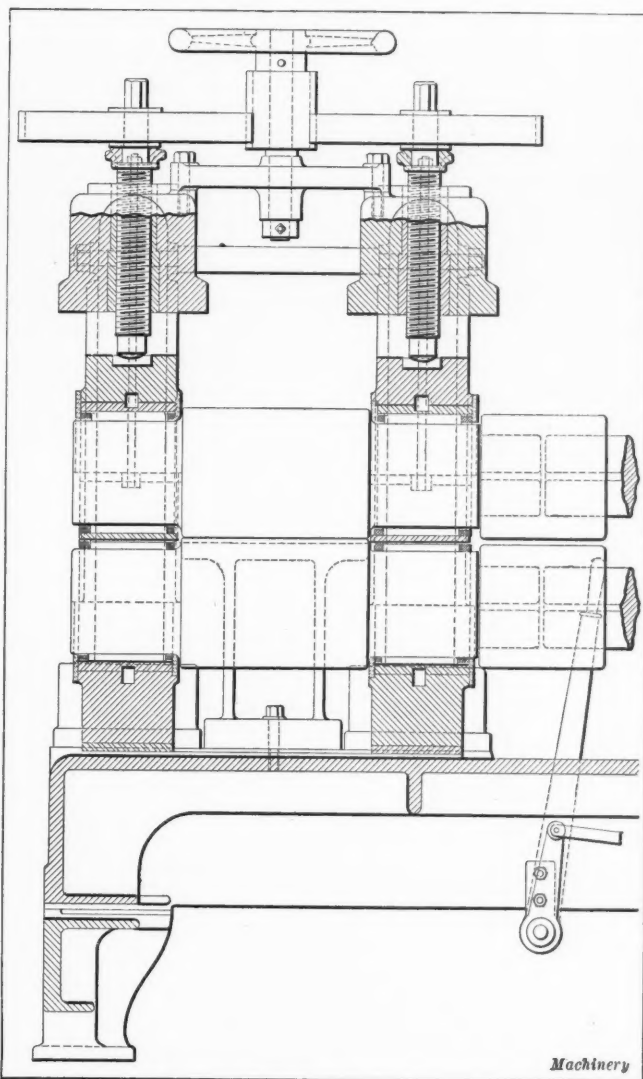


Fig. 7. Section through Head End of Rolling Mill

being quenched. At one side of the quenching tank there is a post about six feet high that acts as a fulcrum for a long oak beam. The short end of this lever is directly over the quenching tank and from it is suspended a hook through which the cradle and the roll to be hardened may be suspended. The opposite end of this long lever is provided with pulley ropes and is manned by two or three laborers just before the roll is quenched.

The quenching tank is six feet in diameter and nine feet deep, and is filled with a saturated brine solution. The tank is provided with a circulating system for keeping the brine cool, and, in addition, a number of small cakes of ice are thrown into the tank just before the hardening operation is commenced.

As soon as possible after the roll has been taken from the heating pot and mounted in the cradle, it is attached to the hook on the dipping beam and quickly plunged under the surface of the brine in the tank. The laborers on the opposite end of the dipping beam slowly raise and lower the roll, not allowing it to appear above the surface of the brine. This motion is kept up for fifteen minutes, and it is then allowed to remain in the water for about ten minutes. The time varies slightly with the size of the roll being



Fig. 8. Quenching the Roll



Fig. 9. Luting Cover in Place preparatory to heating Roll

quenched. After the expiration of this time the roll is transferred from the brine tank to the oil tank for drawing the temper. The oil in this tank is a heavy fish oil and is kept at a temperature of 400 degrees F. The roll is allowed to remain in the tempering oil for from one-half hour to three hours, according to the size. It is then removed and wrapped in heavy burlap and allowed to cool gradually to the temperature of the room.

Testing for Hardness

In testing rolls for hardness, the file is used for surface tests and the

Grinding and Lapping Rolls

The next operations on the rolls before they are inserted in the rolling mill are grinding and lapping. The grinding is an ordinary operation, and consists in finishing on a cylindrical grinder, removing from 0.040 to 0.080 inch, according to the size and condition of the roll. The journals are ground nearly as carefully as the working surfaces of the rolls. After the roll surface has been ground as fine as possible, it is lapped on a cylindrical grinder that is kept apart for that purpose. The lapping is done with a lead lap about 12 inches in diameter, having a one-inch face. Thus the lapping operation is also a cylindrical grinding job in which a charged lead disk is used instead of an abrasive wheel. Crocus and oil are used in paste form, and the lapping operation is continued until the surface is mirror-like in its finish. To lap a roll successfully, the machine on which the work is done must be in a part of the shop where it will not be affected by the slightest vibration. This operation completes the manufacture of the roll, and it is now ready for its place in the rolling mill.

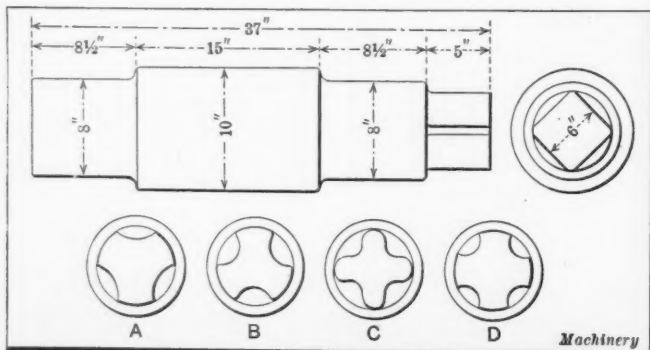
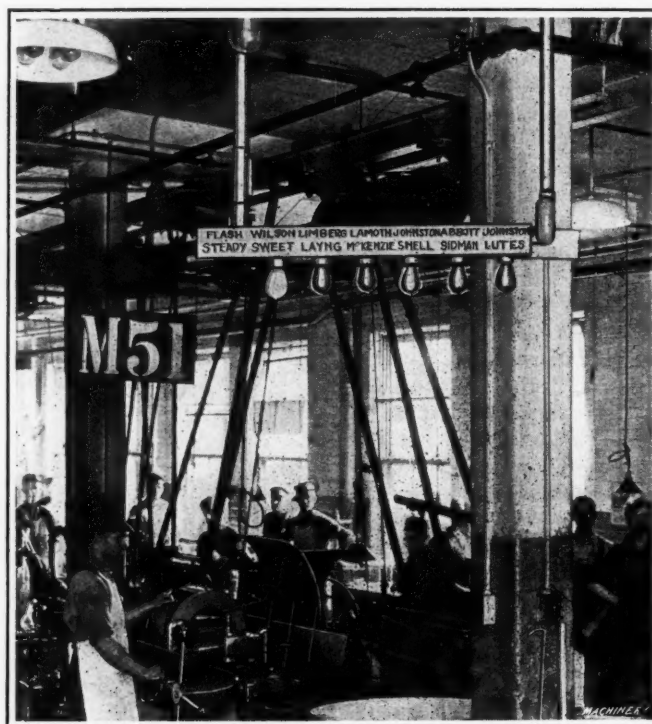


Fig. 10. Typical Roll with Dimensions, and Several Types of Wabblers

FACTORY CALL SYSTEM

Attention has frequently been called to the harmful effects of noise upon the efficiency of workmen. The fact has been fairly well established that both the amount and quality of product turned out in an excessively noisy shop will be inferior to that produced under better working conditions. Investigators have also reached the conclusion that the number of accidents occurring in a shop where there is a great amount of noise is likely to be abnormally large.

For the purpose of calling officials while out in the factory, the Cadillac Motor Car Co., Detroit, Mich., uses a signal light system which entirely does away with the noise incident to many call systems. It will be seen that this consists of a series of colored electric lights which are operated from the telephone switchboard, and that each light provides for calling two men according to whether it is flashed on and off or allowed to glow steadily. As this system is simple and eco-



Signal Lamp System for calling Men to Telephone

nomical, and does not add to the noise in the shop, it is one that should commend itself to the attention of many manufacturers.

E. K. H.

* * *

IMPROVED INTERNAL TRANSPORTATION FACILITIES

A twenty-story hotel, costing \$9,000,000, will be erected opposite the Pennsylvania Station, New York City. When completed the hotel will contain 2200 rooms. It will be located on Seventh Ave., between 32nd and 33rd Sts. A subway station connecting with the hotel basement will give access to the new subway system and a tunnel will connect it with the Pennsylvania Station opposite. It will be possible for a guest to go to any part of the city reached by the subway system, or to take trains for the West, South, North or New England without going from under cover. The local and long-distance transportation facilities are nearly ideal. This is in refreshing contrast to the time—not so long ago—when each city and town tried to make it difficult for a traveler to pass through on his journey without spending much money for lodging, food and local transportation. The modern theory of efficiency is directly opposed to the old obstructionist's idea. A great city like New York gains by facilitating the transaction of business. The traveler who can go about easily and cheaply and who is properly taken care of while he is within the "city's gates" will, in the end, be more profitable than he who is cheated and tricked, delayed in the transaction of his business and met at every turn by demands for "baksheesh."

JIG AND FIXTURE DETAILS—CLAMPS AND STRAPS

STANDARDS USED BY GENERAL ELECTRIC CO.

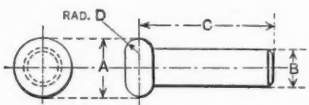
BY R. F. POHLE*

IN the design of jigs and fixtures, there are a great many details that may be standardized. Tables I to V show dimensions used for different kinds of pins used in jig de

sign. These tables embody the practice of the General Electric Co., at Lynn, Mass., the standards having been developed by R. F. Pohle, in charge of one of the tool designing departments.

* Address: General Electric Co., Lynn, Mass.

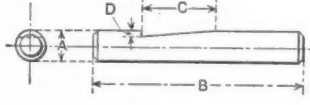
TABLE I. JIG STOP-PINS



A	B	C	D
1/4	0.1885	3/8 to 5/8	1/16
5/16	0.1885	1/2 to 3/4	3/32
3/8	0.251	1/2 to 3/4	3/32
7/16	0.3135	1/2 to 1 1/8	3/32
1/2	0.376	1/2 to 1 1/4	3/32
5/8	0.4385	5/8 to 1 3/8	1/8
3/4	0.501	3/4 to 1 1/2	1/8
7/8	0.564	7/8 to 2	3/32
1	0.6265	7/8 to 2	3/32
	0.7515	1 to 2 1/8	3/16

Machinery

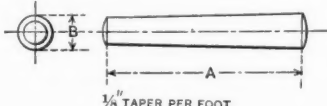
TABLE II. MILLED SPRING-PINS



A	B	C	D
0.1865	3/4 to 1 1/2	3/8	3/16
0.249	1 to 2	1/2	1/8
0.3115	1 1/4 to 2 1/2	1 1/8	5/16
0.374	1 1/2 to 3 1/2	3/4	3/32
0.4365	1 3/4 to 4 1/2	7/8	3/32
0.499	2 to 5 1/2	1	5/16
0.5615	2 1/4 to 6 1/2	1	1/8
0.623	2 1/2 to 7 1/2	1 1/8	3/32
0.748	2 3/4 to 8 1/2	1 1/4	3/32
0.873	3 to 9	1 3/8	1/8
0.998	3 to 9 1/2	1 5/8	3/16

Machinery

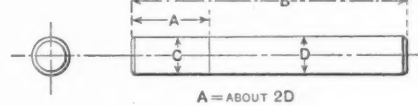
TABLE III. TAPER HINGE-PINS



A	B	A	B	A	B
5/8 to 1	0.107	3/4 to 1 1/2	0.176	1 3/8 to 3 1/8	0.325
3/4 to 1 1/8	0.121	3/4 to 2	0.202	2 1/8 to 3 5/8	0.384
3/4 to 1 1/4	0.137	1 to 2 3/8	0.234	2 3/4 to 4 1/2	0.451
3/4 to 1 1/2	0.155	1 to 2 1/2	0.276	2 3/4 to 4 3/4	0.532

Machinery

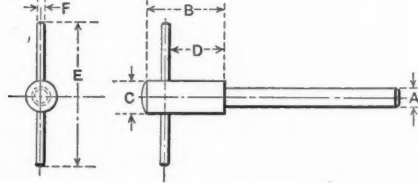
TABLE IV. STRAIGHT HINGE-PINS



B	C	D	B	C	D
1/2 to 1 1/2	0.126	0.124	1 3/4 to 4 1/2	0.376	0.374
1/2 to 1 3/4	0.1572	0.1552	2 to 5	0.4385	0.4365
3/4 to 2	0.1885	0.1865	2 1/2 to 5 1/2	0.5015	0.4985
1 to 2 1/2	0.2197	0.2177	3 to 6 1/2	0.6265	0.6235
1 1/4 to 3	0.251	0.249	3 1/2 to 7 1/2	0.7515	0.7485
1 1/2 to 4	0.3135	0.3115			

Machinery

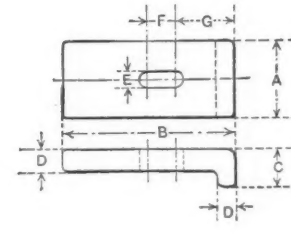
TABLE V. JIG DRAW-PINS



A	B	C	D	E	F
0.750	2	1 1/8	1 1/4	3	1/4
0.7812	2	1 1/8	1 1/4	3	1/4
0.8125	2 1/8	1	1 3/8	3 1/8	1/4
0.8437	2 1/8	1	1 3/8	3 1/8	1/4
0.875	2 1/4	1 1/8	1 1/2	3 1/4	1/4
0.9062	2 1/4	1 1/8	1 1/2	3 1/4	1/4
0.9375	2 3/8	1 1/8	1 5/8	3 1/2	1/8
0.9687	2 3/8	1 1/8	1 5/8	3 1/2	1/8
1.000	2 1/2	1 1/4	1 3/4	3 3/4	1/8
1.0625	2 1/2	1 1/4	1 3/4	3 3/4	1/8
1.125	2 5/8	1 3/8	1 3/4	4	1/8
1.1875	2 5/8	1 3/8	1 3/4	4	1/8
1.250	2 3/4	1 1/2	1 7/8	4 1/4	3/8
1.3125	2 3/4	1 1/2	1 7/8	4 1/4	3/8
1.375	2 7/8	1 5/8	1 7/8	4 1/2	3/8
1.4375	2 7/8	1 5/8	1 7/8	4 1/2	3/8
1.500	3	1 3/4	2	4 3/4	3/8

Machinery

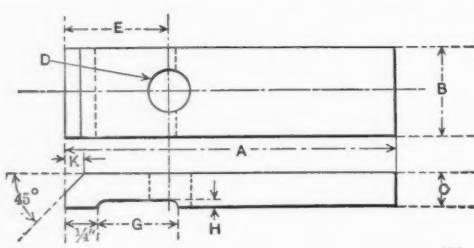
TABLE VI. FORGED STRAPS



A	B	C	D	E	F	G
3/4	1 1/8 to 1 1/8	3/8	1/4	1 1/8	3/8	7/16
3/4	2 3/8 to 2 7/8	3/8	1/4	1 1/8	1/2	7/16
1 1/8	1 1/8 to 2 7/8	1/2	1/8	1 1/8	3/4	5/8
1 1/8	2 7/8 to 2 11/8	1/2	1/8	1 1/8	1/2	5/8
1 1/8	2 to 2 3/4	1/2	3/8	1 1/8	1/2	5/8
1 1/8	3 1/8 to 3 1/2	1/2	3/8	1 1/8	1/2	5/8
1 1/2	2 1/2 to 3	3/4	1/2	1 1/2	1	1
1 1/4	3 1/2 to 4	3/4	1/2	1 1/2	3/4	1
1 1/4	4 1/2 to 5	3/4	1/2	1 1/2	1	1 1/4
1 1/2	3 1/2 to 4	1	5/8	1 1/2	3/4	1 1/4
1 1/2	4 1/2 to 5	1	5/8	1 1/2	1 1/8	1 1/4
1 1/2	5 1/2 to 6	1	5/8	1 1/2	1 1/2	1 1/4
1 3/4	4 to 4 3/4	1 1/4	3/4	1 3/4	1	1 3/8
1 3/4	5 1/2 to 6 1/4	1 1/4	3/4	1 3/4	1 1/2	1 3/8
1 3/4	7 to 7 3/4	1 1/4	3/4	1 3/4	2	1 3/8

Machinery

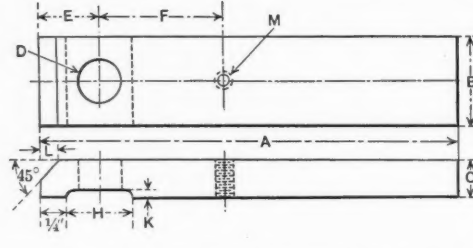
TABLE VII. CLAMP STRAPS



A	B	C	D	E	G	H	K
1 1/8	1 1/8	1/8	1/8	3/4	1/2	1/8	1/8
2 1/8	1 1/8	1/8	1/8	3/8	1/2	1/8	1/8
2 1/8	1 1/8	1/8	1/8	1	1/2	1/8	1/8
3 1/8	1 1/8	1/8	1/8	1 1/4	1/2	3/8	1/8
4 1/8	1 1/8	1/8	1/8	1 1/2	1/2	3/8	1/8
2	1 1/8	3/8	3/8	3/4	1/8	3/8	1/8
2 1/2	1 1/8	1/8	3/8	1	1/8	3/8	1/8
3	1 1/8	1/8	3/8	1 1/8	5/8	3/8	1/8
3 3/4	1 1/8	1/8	3/8	1 1/4	5/8	1/8	1/8
5	1 1/8	5/8	3/8	1 1/2	3/4	1/8	1/4
2 3/8	1 1/8	1/8	1/2	3/4	5/8	3/8	1/8
2 1/8	1 1/8	1/8	1/2	1	5/8	3/8	1/8
3 1/8	1 1/8	1/8	1/2	1 1/8	3/4	3/8	1/4
3 1/8	1 1/8	1/8	1/2	1 1/4	3/4	3/8	1/4
5 3/8	1 1/8	1/8	1/2	1 1/2	7/8	1/8	1/8
2 3/4	1 1/4	1/2	1/2	3/4	5/8	3/8	1/8
2 3/4	1 1/4	1/8	1/2	1	5/8	3/8	1/8
3 1/4	1 1/4	1/8	1/2	1 1/8	3/4	3/8	1/4
4	1 1/4	1/8	1/2	1 1/4	3/4	1/8	1/4
5 1/4	1 1/4	3/4	1/2	1 1/2	1	1/8	1/8
6 3/4	1 1/4	1 1/8	1/2	2	1	1/8	1/8
4 5/8	1 7/8	5/8	5/8	1 1/4	3/4	1/8	1/4
5 5/8	1 7/8	1 1/8	5/8	1 1/2	7/8	1/8	1/8
6 5/8	1 7/8	3/4	5/8	1 7/8	7/8	1/8	1/8
7 5/8	1 7/8	1 1/8	5/8	2 1/4	1	1/8	3/8
8 5/8	1 7/8	7/8	5/8	2 3/4	1	1/8	3/8

Machinery

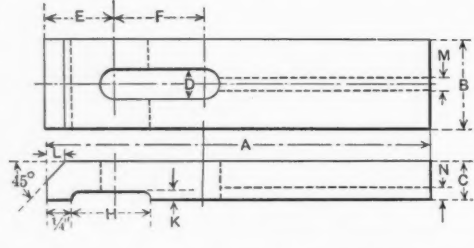
TABLE VIII. LATCH STRAPS



A	B	C	D	E	F	H	K	L	M Diameter and Number of Threads per Inch
1 1/8	1 1/8	1/8	1/2	1/8	1	1/2	1/8	1/8	No. 14-24
2 1/8	1 1/8	1/8	1/2	3/4	1	1/2	1/8	1/8	No. 14-24
2 1/8	1 1/8	1/8	1/2	1	1	1/2	1/8	1/8	No. 14-24
3 1/8	1 1/8	1/8	1/2	1	1	1/2	3/8	1/8	No. 14-24
4 1/8	1 1/8	1/8	1/2	1	1	1/2	3/8	1/8	No. 14-24
2	1 1/8	3/8	1/2	5/8	1	1/8	3/8	1/8	No. 14-24
2 1/2	1 1/8	1/8	1/2	3/4	1	1/8	3/8	1/8	No. 14-24
3	1 1/8	1/8	1/2	1	1	1/8	3/8	1/8	No. 14-24
3 3/4	1 1/8	1/8	1/2	1 1/4	1	5/8	1/8	1/8	No. 14-24
5	1 1/8	5/8	1/2	1 1/4	1	3/4	1/8	1/4	No. 14-24
2 3/8	1 1/8	1/8	1/2	3/4	1	5/8	3/8	1/8	No. 14-24
2 1/8	1 1/8	1/8	1/2	1	1	5/8	3/8	1/8	No. 14-24
3 1/8	1 1/8	1/8	1/2	1 1/8	1	3/4	3/8	1/4	No. 14-24
3 1/8	1 1/8	1/8	1/2	1 1/4	1	3/4	3/8	1/4	No. 14-24
5 3/8	1 1/8	1/8	1/2	1 1/2	1	7/8	1/8	1/8	No. 14-24
2 3/4	1 1/4	1/2	3/4	3/4	1 1/8	5/8	3/8	1/8	1/8-18
2 3/4	1 1/4	1/8	3/4	1	1 1/8	5/8	3/8	1/8	1/8-18
3 1/4	1 1/4	1/8	3/4	1 1/8	1 1/8	3/4	3/8	1/4	1/8-18
4	1 1/4	1/8	3/4	1 1/4	1 1/8	3/4	1/8	1/4	1/8-18
5 1/4	1 1/4	3/4	3/4	1 1/2	1 1/8	1	1/8	1/8	1/8-18
6 3/4	1 1/4	1 1/8	3/4	1 3/4	1 1/8	1	1/8	1/8	1/8-18
4 5/8	1 7/8	5/8	7/8	1	1 1/4	3/4	1/8	1/4	1/8-18
5 5/8	1 7/8	1 1/8	7/8	1 1/2	1 1/4	7/8	1/8	1/8	1/8-18
6 5/8	1 7/8	3/4	7/8	1 3/4	1 1/4	7/8	1/8	1/8	1/8-18
7 5/8	1 7/8	1 1/8	7/8	2	1 1/4	1	1/8	3/8	1/8-18
8 5/8	1 7/8	7/8	7/8	2	1 1/4	1	1/8	3/8	1/8-18

Machinery

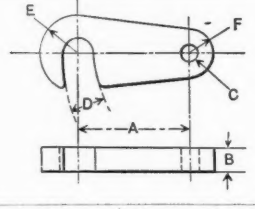
TABLE IX. SLIDE STRAPS



A	B	C	D	E	F	H	K	L	M	N
1 1/8	1 1/8	1/8	1/2	1/8	3/8	1/2	1/8	1/8	1/8	1/8
2 1/8	1 1/8	1/8	1/2	1/8	1/2	1/2	1/8	1/8	1/8	1/8
2 1/8	1 1/8	1/8	1/2	1/8	3/4	1/2	1/8	1/8	1/8	1/8
3 1/8	1 1/8	1/8	1/2	1/8	1	1/2	3/8	1/8	1/8	1/8
4 1/8	1 1/8	1/8	1/2	1/8	1 1/8	1/2	3/8	1/8	1/8	1/8
2	1 1/8	3/8	1/2	1/8	3/8	1/8	3/8	1/8	1/8	1/8
2 1/2	1 1/8	1/8	1/2	1/8	1/2	1/8	3/8	1/8	1/8	1/8
3	1 1/8	1/8	1/2	1/8	3/4	5/8	3/8	1/8	1/8	1/8
3 3/4	1 1/8	1/8	1/2	1/8	1 1/8	5/8	3/8	1/8	1/8	1/8
5	1 1/8	5/8	1/2	1/8	1 3/4	3/4	1/8	1/4	1/8	1/8
2 1/2	1 1/8	1/8	1/2	1/8	1/2	1/8	3/8	1/8	1/8	1/8
2 1/8	1 1/8	1/8	1/2	1/8	3/4	5/8	3/8	1/8	1/8	1/8
3 1/8	1 1/8	1/8	1/2	1/8	1	5/8	3/8	1/8	1/8	1/8
3 1/8	1 1/8	1/8	1/2	1/8	1 1/8	5/8	3/8	1/8	1/8	1/8
5 3/8	1 1/8	1/8	1/2	1/8	1 1/2	7/8	1/8	1/8	1/8	1/8
2 3/4	1 1/4	1/2	3/4	3/8	1/2	5/8	3/8	1/8	1/8	1/8
2 3/4	1 1/4	1/8	3/4	1	3/4	5/8	3/8	1/8	1/8	1/8
3 1/4	1 1/4	1/8	3/4	1 1/8	3/4	5/8	3/8	1/8	1/8	1/8
4	1 1/4	1/8	3/4	1 1/4	1	5/8	3/8	1/8	1/8	1/8
5 1/4	1 1/4	3/4	3/4	1 1/2	1 1/8	1	1/8	1/4	1/8	1/8
6 3/4	1 1/4	1 1/8	3/4	1 3/4	1 1/8	1	1/8	1/4	1/8	1/8
4 5/8	1 7/8	5/8	7/8	1	1 1/4	3/4	1/8	1/4	1/8	1/8
5 5/8	1 7/8	1 1/8	7/8	1 1/2	1 1/4	7/8	1/8	1/4	1/8	1/8
6 5/8	1 7/8	3/4	7/8	1 3/4	1 1/4	7/8	1/8	1/4	1/8	1/8
7 5/8	1 7/8	1 1/8	7/8	2	1 1/2	1	1/8	1/4	1/8	1/8
8 5/8	1 7/8	7/8	7/8	2 1/4	1 3/4	1	1/8	1/4	1/8	1/8

Machinery

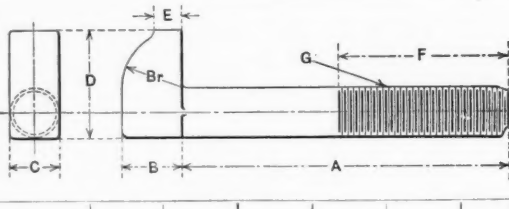
TABLE X. LATCHES



A	B	C	D	E	F
1	1/4	1/4	3/8	3/8	1/4
1	1/4	1/4	3/8	3/8	1/4
1 1/8	1/4	1/4	3/8	3/8	1/4
1 1/4	3/8	1/8	3/8	3/8	1/8

Machinery

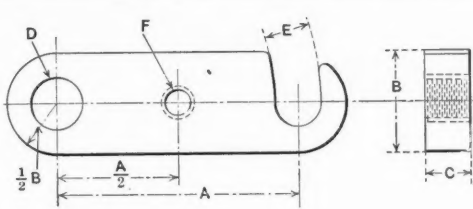
TABLE XI. HOOK BOLTS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
1 1/2 to 4	1/8	3/8	1 1/8	1/8	1 1/8	3/8-16
1 3/4 to 5	1/8	1/2	1 1/8	1/8	1 3/8	1/2-13
2 to 7	1 1/8	5/8	1 1/8	1/8	1 5/8	5/8-11
2 1/2 to 8	1 1/8	3/4	1 1/8	1/8	2	3/4-10
3 1/4 to 9 1/4	1 1/8	7/8	1 1/8	1/8	2 1/4	7/8-9
4 to 10 1/2	1 1/8	1	2 1/8	1/2	2 1/2	1-8

Machinery

TABLE XII. SWING STRAPS



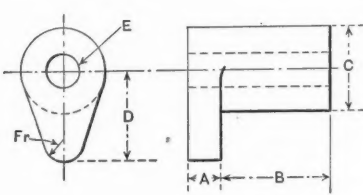
A	B	C	D	E	F Diameter and Number of Threads per Inch
2 to 2 1/8	3/4	3/8	0.375	1 1/8	1/8-18
3 to 3 1/8	1	1/2	0.500	1 1/2	3/8-16
4 to 4 1/8	1	1/2	0.500	1 1/2	1/2-13
5 to 6	1 1/4	5/8	0.625	2 1/2	1/2-13

Machinery

Jig Stop-pins

The function of jig stop-pins is, as the name implies, to stop the work in a predetermined location. This location is determined with reference to the guides or locating surfaces. The type of jig stop-pin illustrated and tabulated in Table I

TABLE XIII. SWING HOOK STRAPS



A	B	C	D	E	F
3/2	1/4 to 1	0	5/8	1 1/8	1/8
1/4	1/8 to 1	5/8	1 1/8	1 1/2	1/8
1/8	1/2 to 1 1/2	3/4	1 1/8	2 1/8	1/8
3/8	1/2 to 2	7/8	1 1/8	2 1/8	1/4
1/2	5/8 to 2 1/4	1	1 1/8	2 1/8	1/8
3/4	3/4 to 2 1/2	1 1/8	1 1/8	3 1/8	3/8
1	7/8 to 3	1 1/8	1 3/8	4 1/8	1/2
3/4	1 to 3 1/2	1 1/8	1 1/8	4 1/8	1/8

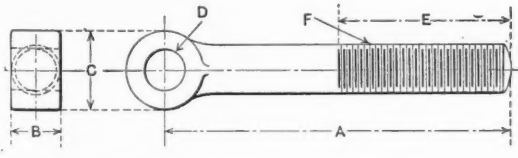
Machinery

is particularly adapted for locating castings and other work with a rough exterior, since it presents a minimum of contact surface and is therefore less likely to stop the work against any rough high spots.

Spring-pins

It is often necessary to support rough work at more than three points, but owing to the fact that it cannot be relied upon

TABLE XIV. SWING BOLTS



A	B	C	D	E	F Diameter and Number of Threads per Inch
1 1/2 to 2 1/8	3/8	1/4	0.125	3/4	No. 10-32
1 1/2 to 3 1/2	1/4	1/8	0.1875	7/8	No. 14-24
1 1/2 to 4	3/8	5/8	0.3125	1 1/8	3/8-16
1 3/4 to 5	1/2	3/4	0.375	1 3/8	1/2-13
2 to 7	5/8	1 1/8	0.500	1 5/8	5/8-11
2 1/2 to 8	3/4	1 1/8	0.625	2	3/4-10
3 1/4 to 9 1/4	7/8	1 1/4	0.750	2 1/4	7/8-9
4 to 10 1/2	1	1 3/8	0.8125	2 1/2	1-8

Machinery

to bear at more than three points, the other bearing points must be made adjustable. The dimensions of spring-pins given in Table II will be found suitable for devices in which designs of this kind are required.

Hinge-pins

There are two types of clamp and jig cover hinge-pins in general use—the straight hinge-pin and the taper hinge-pins. The straight hinge-pin is used more than the tapered pin on account of the expense of making the latter, and of the reaming of a corresponding tapered hole. The reason for making tapered pins is to compensate for wear. The usual taper is 1/8 inch per foot; the usual taper of ordinary taper pins—1/4 inch per foot—is too great for this purpose. Straight pins are made from high-carbon steel. They are not hardened, but are ground to a running fit with the exception of one end, which may be made a drive fit for a length equal to two diameters of the pin. When the practice is to bore out the holes for the hinge-pins, pins less than 7/16 inch in diameter should be avoided, because smaller pins would necessitate the use of boring tools that would not be rigid enough to insure a true hole.

Clamps and Straps

Plain horizontal clamps or straps for use on finished surfaces are shown in Tables VII to IX. The style shown in Table VII is intended for use with work where it is desired to swing the strap around the clamp-screw in order to clear the work. The latch strap, Table VIII, is used in combination with a latch—Table X—and a shoulder screw. The under side of these straps is relieved; otherwise, if the straps should spring under the pressure of the clamping screw, the strap would bear on the edge of the work. The other types of straps and clamping bolts are used for special requirements, whenever the design permits.

* * *

COST OF HIGH-EXPLOSIVE SHELLS

The prices paid for high-explosive shells of various sizes differ greatly in this country, Canada and Great Britain. The accompanying table gives the prices paid in February for British high-explosive shell bodies and forgings, varying from the 15-pound up to the 6-inch high-explosive. In referring to this table, it will be noticed that the Canadian manufacturers have greatly reduced the cost of both forgings and machined shell bodies. The 4.5-inch shell forging has been reduced several times; the first lot was placed at \$4.25, the second at

COST OF BRITISH HIGH-EXPLOSIVE SHELL

Size of Shell	Operation	Cost in U. S. A.	Cost in Canada	Cost in G. Britain
15-pound	Forging and Machining	.....	\$8.30	.....
18-pound	Forging and Machining	.....	8.50	.....
18-pound	Machining	.....	1.85	\$3.81
4.5-inch	Forging and Machining	\$9.81	7.45	10.33
4.5-inch	Forging	.....	2.95	4.50
6-inch	Machining and Forging	.....	16.85	19.94
6-inch	Forging	.....	7.50	9.73

Machinery

\$3.60, and the price now paid is \$2.95. The price then being paid for complete rounds of 15-pound British shrapnel was \$16.85. Twenty-two million shells had been turned out up to this time by Canadian manufacturers, consuming 800,000,000 pounds of steel, 45,000,000 pounds of brass, zinc and copper, 22,000,000 pounds of copper alone, 102,000,000 pounds of lead, 400,000,000 pounds of black powder, 10,000,000 pounds of cordite, 11,000,000 pounds of trinitoluene and 4,000,000 pounds of other explosives. More than 1,100,000 shells are being shipped monthly by Canadian manufacturers, and the total shell orders received amount to approximately \$350,000,000.

* * *

The total resistance to shear when cutting hot steel may be obtained by the following formula:

$$R = 1.1 \left(\frac{5000}{\sqrt{A}} \times A \right)$$

in which

A = area of cross-section in square inches;

R = total resistance to shear in pounds.

GROUP INSURANCE PLAN OF THE CHAIN BELT CO. DAVID BROWN & SONS WORM GRINDER

The Chain Belt Co., Milwaukee, Wis., manufacturer of chain belts, sprocket wheels, elevating and conveying machinery, concrete mixers, etc., has developed a new plan of group insurance. Under the single policy written by the company each employe who has been with the concern two years or more is given a straight life insurance to the amount of \$1000, and those who have been employed less than two years are insured for \$500. In the latter class those who complete two years' service will be given the \$1000 policy. William C. Frye, president of the company, has written a letter to each employe, from which the following extract is taken:

In order to show our appreciation of loyal and efficient service, I have been instructed by the board of directors to announce that the Chain Belt Co. has contracted with the Equitable Life Assurance Society to insure the lives of those between the ages of twenty-one and sixty-five who have been in our employ continuously for one year or more on April 20, 1916, for the sum of \$500, and those who have been in our employ continuously for two years on April 20, 1916, for the sum of \$1000 each. In the case of the employe who has been with the company for one year a substitute certificate for \$1000 will be given her or him when the term of continued employment will have reached the two-year period. All new employes over twenty-one years of age will receive a certificate for \$500 after one year's service. When an employe leaves the insurance expires.

This is time insurance and is given without charge, and in the event of death while the policy is in force the beneficiary named will be paid the amount of the policy by the insurance company. It will be issued for the year ending April 20, 1917, but it is our intention to renew from year to year unless it shall prove unsatisfactory or experience suggests an amendment.

The Bureau of the Census, Department of Commerce, Washington, D. C., reports that ninety-four establishments were engaged in the manufacture of motorcycles, bicycles and parts during 1914. The value of their products amounted to \$25,486,942. The total number of establishments engaged in the manufacture of motorcycles, bicycles and parts in 1909 was 122, but the total value of their products amounted to only \$12,069,687. The number of motorcycles produced in 1914 was 62,793, valued at \$12,306,447; and 398,899 bicycles, valued at \$5,361,229.

For the purpose of correcting worm threads which have been distorted in hardening, David Brown & Sons, Ltd., of Lockwood, Huddersfield, England, have developed the grinding machine shown in the accompanying illustrations. The work to be ground is rotated on fixed centers and traversed past

the grinding wheel. The machine is driven by a single friction pulley A, Fig. 2, from which power is transmitted to gear-box B that gives ten changes of speed. From the gear-box, motion is carried through a worm and wheel C, Fig. 4, which rotates driving plate D of the fixed head E. The required lead for the worm thread is obtained by change-gears mounted on studs F at the top of fixed head E, the motion being transmitted through the differential gear G, Fig. 5, to a lead-screw.

While the worm is being moved past the grinding wheel by a combination of tra-

verse and rotary movements, the worm thread is ground by the face of wheel H. The wheel spindle is driven by pulley J from which the power is transmitted through bevel gears; and the wheel head is so designed that the wheel may be easily set in the proper relation to the worm thread both as regards the spiral angle and thread angle. The spiral angle is governed by the position of the wheel spindle which is adjusted by the vertical circular slide K, and by the horizontal slide in base L. The method of setting the spindle will be best understood by referring to Figs. 2 and 3.

With the preceding general statement of the features of the machine as a guide, we are in a position to take up certain interesting details of its construction. The grinding operation is performed while the worm is traversed past the wheel by a feed motion obtained from gear-box B, but the return motion is effected through a direct drive and is at high speed. The trip gear, which is operated automatically by a dog and lever, causes a high-speed clutch to engage and rapidly with-

draw the grinding wheel at the moment of reversal. At the end of the return stroke the trip gear causes another reversal and allows the grinding wheel to approach the worm thread until it reaches a micrometer stop. During the quick-return stroke the differential comes into action and causes the worm to be automatically indexed for grinding the next thread. The index change-gears are shown at N and the

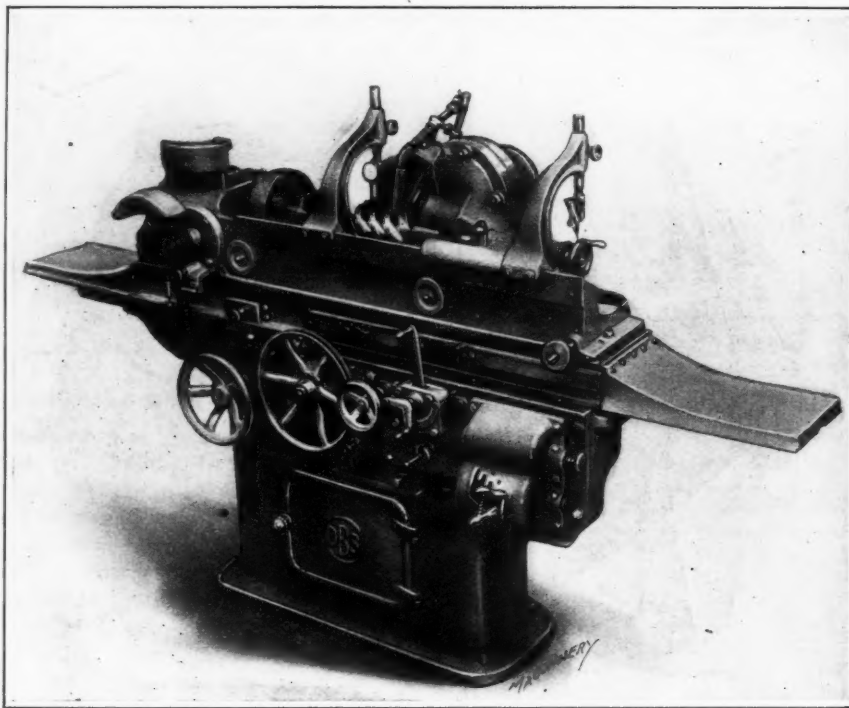


Fig. 1. Front View of David Brown & Sons Worm Grinder, showing Feature of Centralized Control

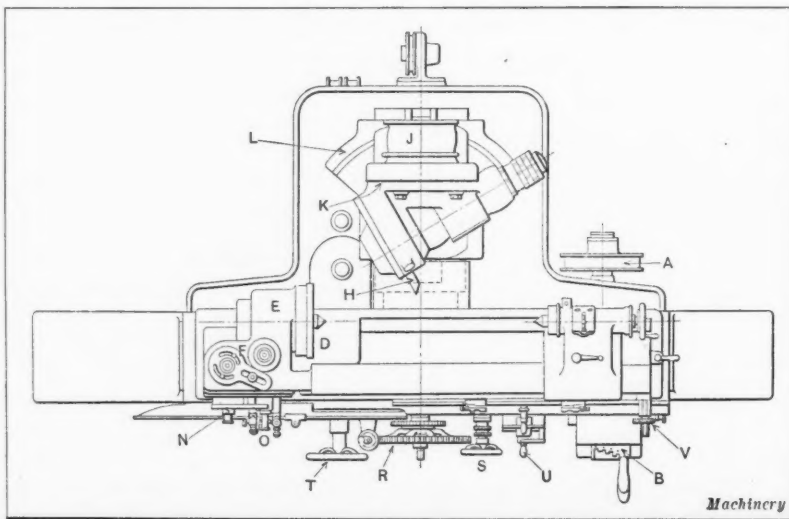


Fig. 2. Plan View of Worm Grinding Machine shown in Figs. 1 and 3

index trip gear at O. Provision is made for eliminating backlash during the quick-return stroke. Right- or left-hand worms may be ground by making suitable adjustment.

It will be evident from Fig. 1 that all handwheels and levers are located at the front of the machine. The central handwheel R controls the automatic movement of the grinding wheel head. Handwheel S is fitted with a micrometer adjustment accurate to 0.0001 inch, and provides for feeding the grinding wheel laterally to the work. This is a special feature designed to retain the correct shape of the worm thread. When the automatic movements are not required, the machine can be operated by hand by means of handwheel T. Lever U provides for stopping all movements at the end of the next quick-return stroke, so that the attendant may have time to gage the work. Then after the gaging has been completed, lever U is once more employed to start the machine upon its next cycle of operations. The top table is pivoted at one end to provide for correction of its parallelism, and it is set for taper grinding by making a proper adjustment of screw V. It will be evident that care has been taken to protect all slides and bearings from damage through abrasive dust finding its way between the working parts.

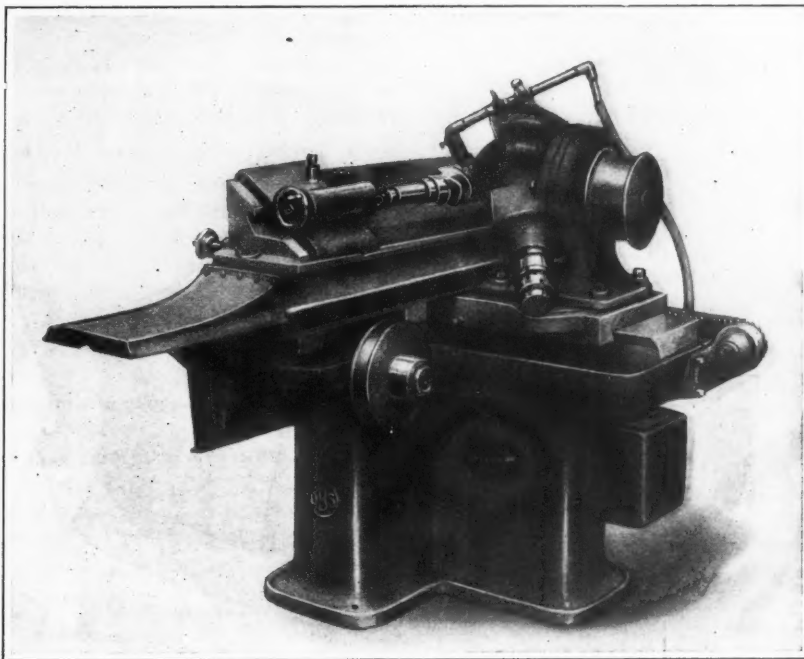


Fig. 3. Rear View of Worm Grinder, showing Work, Single Pulley Drive, and Arrangement of Wheel Head

owner of the clock was "from Missouri," and he called in an expert. The expert was of the investigating type that takes a clock to pieces and finds the cause of trouble with the same joy that a scientist discovers a new gas or an astronomer finds a new double star. He found that this clock, made by a reputable clock maker whose name is a household word throughout the world, had an imperfect escapement wheel; the

teeth were not concentric with the shaft, the hands were not properly counterweighted, and the wheels were out of balance. The works were taken apart, each wheel was poised and balanced, holes being drilled to remove the surplus metal. The escapement was counterpoised to make it beat synchronously with the pendulum. The reason that balancing the wheels and counterbalancing the hands is important is that at some time in the twenty-four hours, all the heavy sides of the wheels and the hands may come together and the main spring may not have power enough to drive

against the unbalanced weights. The result is that the clock stops. The fact that this clock runs and keeps good time since the changes were made indicates that the vibrations of the building did not seriously interfere with the working of the clock. The fault was due to the imperfections of design and manufacture—imperfections that the buyer had a right to expect would not exist in a high-priced timepiece.

SCIENTIFIC CLOCK REPAIRING

The repairing of clocks is looked on as a tinker's job, but a skilled mechanic may devote his attention to scientific clock repairing quite profitably. An eight-day clock had been in use about two years when it began to give trouble by stopping. The representative of the clock maker was called in, and he tinkered with the clock two or three times, but did not stop the trouble. The claim was made that the vibration of the twelve-story building interfered with the beat of the pendulum and when the movements of the building coincided with those of the pendulum the inevitable result was stopping. The

"Circular mil" is a term used in electrical wire measurements with which the ordinary mechanical man is unfamiliar. In the measuring of diameters and areas of electric wires, this measurement is commonly used. A circular mil is the area of a circle 0.001 inch in diameter. The expression "circular inch" is also used. A circular inch is the area of a circle 1 inch in diameter. Hence, 1 circular inch equals 1,000,000 circular mils. A circular inch also equals 0.7854 square inch, and a square inch equals 1.2732 circular inch, or 1,273,239 circular mils.

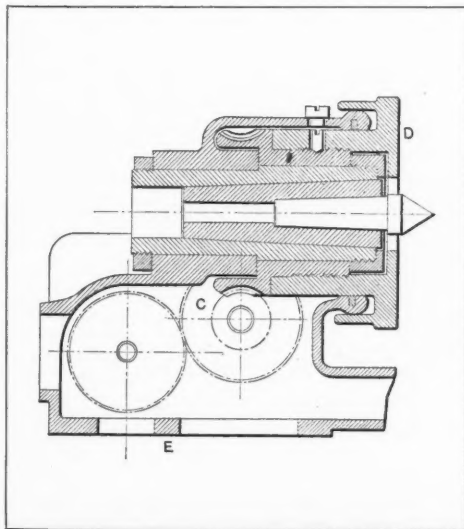


Fig. 4. Cross-section through Driving Center showing Drive through Worm and Wheel C

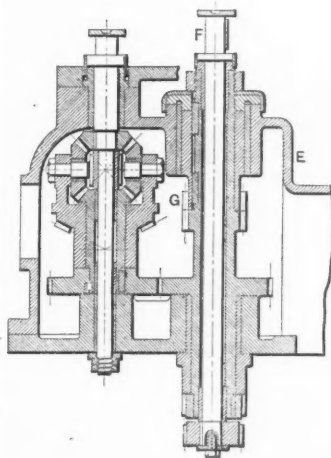


Fig. 5. Gearing provided to give Required Lead for Worm Thread

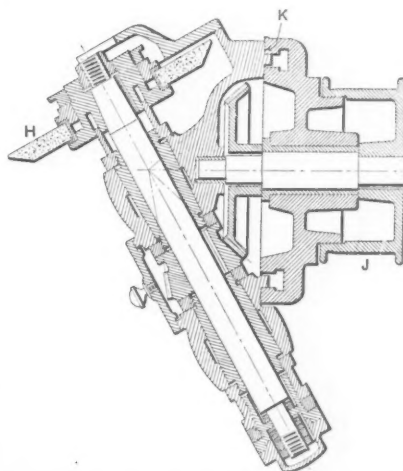


Fig. 6. Cross-section through Wheel Spindle, showing Arrangement of Drive

DRILLING MACHINE DESIGN

SOME DEFECTS AND SUGGESTIONS FOR IMPROVEMENT

BY A. USER

NO matter how many nor how few machine tools may be used in finishing a machine part, the drilling machine is nearly always included; yet this machine seems to have received less consideration and study by designers than most other metal working machines. In MACHINERY'S "Product Index" to advertisers there is usually a full column or more devoted to drilling machines of various types; yet, how many of these machines will bear an analytical examination by an efficiency student and come through without serious demerits charged against them? This refers particularly to machines intended for medium weight work, although several of the criticisms apply with equal force to nearly all types.

Limitations in Speed Range

First, let us consider speed and feed limitations and gradations—the most universal faults of the drilling machine. The writer has before him a late catalogue of a recently developed line of drilling machines of the single-pulley all-g geared type, manufactured by a well-known firm; these machines are probably as advanced in design as any in their field. Selecting a twenty-four inch single-spindle vertical machine as an example, we find that the speed limitations are from 25 to 248 R. P. M. and that the speeds available are eight in number as follows: 25, 40, 50, 62, 100, 157, 197 and 248 R. P. M., or, expressed in percentage, the increases in speed from the lowest to the highest are made in the following erratic order, 60, 25, 24, 61 +, 57, 25 + and 26 — per cent. Assuming that the nature of the metal to be drilled is such that high-speed drills may be run at 60 feet per minute peripheral speed with the greatest efficiency, these speeds will be correct for drills of about the following diameters: 9, 5 5/8, 4 9/16, 3 11/16, 2 5/16, 1 7/16, 1 3/16 and 15/16 inch, respectively; or for carbon steel drills of about half the diameters given.

It is difficult to conceive to what class of customers the designer was catering when he designed this machine. It is more elaborate and expensive than one could hope to sell readily to the little shops and repair men, and as a manufacturing tool, it probably would never be called upon to drive a 9-inch drill and but very seldom a 2 5/16-inch drill. Furthermore, all progressive manufacturers have long since found that they cannot afford to use carbon steel drills, so of what use are the four lower speeds? How are drills under 15/16 inch diameter to be handled efficiently? The writer's experience is that drills less than 15/16 inch in diameter are more often used in 24-inch machines than larger ones. How are drills of intermediate sizes to be driven efficiently? Suppose, for example, that we wish to drive a 2 1/2-inch drill and that the speed of 100 R. P. M. (which is correct for a drill of 2 5/16 inches diameter) is prohibitive because of the unreasonable amount of changing and grinding occasioned thereby; our only alternative, then, is to drop to 62 R. P. M., with a resultant efficiency of about 67 per cent. In other words, if the proper speed (92 R. P. M.) could be obtained, the output would be 48 per cent greater. Running at the top speed of 248 R. P. M., the efficiency of drills under 15/16 inch diameter would be about as follows: 1/4 inch, 27 per cent; 3/8 inch, 41 per cent; 1/2 inch, 54 per cent; 5/8 inch, 68 per cent; 3/4 inch, 81 per cent; 7/8 inch, 95 per cent. For what class of trade were speeds made to vary by steps of from 24 to 61 per cent?

I might also cite the case of another make of drilling machine of this size and the same type except that speed changes are accomplished by the familiar four-step cone pulley and back-gears. This machine has been very popular for many years, and if you run it at about double the speed recommended you can obtain a speed range of from 13 to 1000 R. P. M. by eight steps as follows: 13, 25, 45, 48, 160, 300, 533 and 1000 R. P. M., which, with 60 peripheral feet per minute as the most efficient speed, would be about correct for drills of the following diameters: 17 5/8, 9 3/16, 5 1/16, 2 3/4, 1 7/16,

3/4, 7/16 and 1/4 inch, respectively. How about the intermediate sizes in this case? If you must run a 13/16-inch drill at a speed which is correct for a 1 7/16-inch drill, it is running with less than 57 per cent efficiency, or in other words, it would be doing over 75 per cent more work if the correct speed were obtainable, other conditions being constant.

Limitations in Feed Range

What is true of speeds is also true of feeds; the first-mentioned machine has eight feed changes as follows: 0.004, 0.007, 0.010, 0.015, 0.021, 0.035, 0.050 and 0.075 inch per revolution, which, expressed in terms of percentage, show advances made by each step from the lowest to be: 75, 43 —, 50, 40, 67 —, 43 — and 50 per cent. Why should we be given the greatest relative feed change where the closer gradations are the most necessary, viz., in the use of the smaller drills?

The second-mentioned machine has eight feeds as follows: 0.006, 0.007, 0.010, 0.017, 0.023, 0.029, 0.040 and 0.064 inch per revolution. These gradations, especially the first four, seem to conform with ordinary needs more than those of the machine first mentioned; yet I fear that conditions occasionally arise when 0.006 inch feed per revolution is too much, for instance, when using small drills in hard, tough stock.

Lack of Rigidity

So much for the most prominent faults of the regulation vertical drilling machine, but it has others which should also be mentioned. One of these is weakness in design, which permits springing under the strain of feed pressure, causing the drill to gouge in as the point breaks through. If the work is tough and hard, the drill "rides" for a turn or two, until sufficient pressure is accumulated to force it to take hold, which it does with such a vengeance, under these conditions, that it results in breakage of the drill or some part of the machine or, more frequently, slipping the belt. Lack of mass, in combination with lack of strength, results in vibration, noise and excessive wear and loosening of joints.

Vibration and Noise of Operation

The use of spur and bevel gears in this class of machinery should also be criticized for the reason that, owing to the relatively high speed, they contribute largely to vibration, and in many cases, especially when considerably worn, they rotate the drill by a rapid succession of impulses not unlike the motion imparted to a chisel by a pneumatic hammer, which, if driving a drill close to its limit of strength is likely to cause breakage. In this connection, let us devote a little thought to the effect of noise upon the efficiency of workmen. By this we mean excessive and unnecessary noise, such as is wearing upon one's nerves and destructive of tranquility of mind and body. It is, of course, impracticable, except possibly by elaborate psychological experiments, to obtain anything approximating a valuation of this factor in "cold cash"; but everyone realizes that it is not possible to accomplish as much work amidst the rattle and clatter of a noisy drill department as it is when the surroundings are comparatively quiet. The effect of noise varies with the temperament of the individual, but let us assume, as a conservative estimate, that the elimination of nerve-racking noise will increase the efficiency of the workman 1 per cent. Would the increased cost of the machine be justified? Assuming that the average drill press operator works eight hours per day, three hundred days per year, and receives 25 cents per hour, $8 \times 0.25 \times 300 \times 0.01 = \6 . Six dollars will pay 12 per cent on \$50. Will it cost \$50 more to provide helical gears instead of spur and bevel gears? No, fifty cents would be more nearly correct (having in mind the ordinary 24-inch drilling machine).

Insufficient Table Support

Another faulty feature of design is the method of supporting the table usually employed by builders of the average 24-

inch drilling machine. Referring to Fig. 1, it will be seen that the knee, or arm, has a relatively short bearing on the column. The design shown in Fig. 2 is a little better in this respect, but neither of these can reasonably be expected to remain square with the spindle for more than a short time. It is evident that the clamping arrangement is such that when the knee is loosened and raised, the dust or chips which lodge on top of the knee and adhere to the column are worked into the joint, and when again clamped, they prevent the knee from coming back to its original position. The many repetitions of this process, combined with the heavy overhang and short bearing on the column, soon produce a condition which makes it impossible to obtain accurate work. Conditions, in all cases where this style of knee is employed, will be improved if a heavy felt wiper is provided to hug the column close at the top of the knee, thus preventing, to a great extent, the admission of dust and grit to this joint. The clamping arrangement would have been improved had the portion of the knee which encircles the column below the nut-ring been split for clamping purposes and the upper portion left solid.

The possibilities of a well built and well tooled drilling machine are large, in many cases surpassing those of more costly

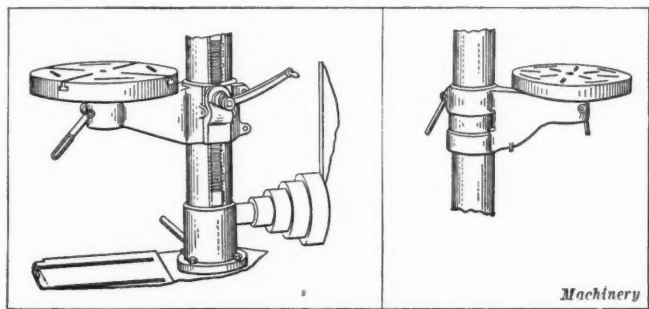


Fig. 1. Drilling Knee with Short Bearing on Column

Fig. 2. Faulty Clamping Arrangement

machinery and higher priced operators; but a table which is square with the spindle is imperative, and this feature alone is worthy of the careful consideration of both designer and purchaser. The writer is acquainted with two manufacturing concerns who have considered this feature of sufficient importance to justify them in building some sizes of drill presses in small lots for their own use, in which particular attention has been given to this point of the design. They have been building these for twelve or fifteen years, at a cost which must necessarily be very high, owing to the comparatively small quantities made at a time and the conditions under which they are constructed. Prominent mechanics who have seen these machines have been favorably impressed, but owing to the fact that they are not on the market, they content themselves as best they may with what they can get.

Summary of Suggested Improvement in Drilling Machine Design

To meet the writer's ideals, a drilling machine should embody the following features:

A speed range to provide a peripheral speed of not more than thirty feet per minute for the largest drill to which the taper hole in the spindle is suited, and not less than eighty feet per minute for the smallest drill which it is reasonable to suppose would be used in the machine for manufacturing operations (let the odd jobs suffer, not the everyday tasks).

Gradations of speeds by 10 per cent increases from lowest to highest.

Feeds fine enough for the smallest drill under difficult conditions and coarse enough for the largest drill under favorable conditions, by gradations of not more than 20 per cent from lowest to highest.

Helical gears throughout for both parallel and angular drives.

Sufficient mass and strength in framework to reduce spring and vibration to a negligible quantity.

Work-table which is so designed that it will maintain its accuracy with relation to the spindle, or one which is not adjustable vertically but may be swung aside if necessary.

A permanently attached speed chart, etched on metal giving the revolutions per minute at which all sizes of drills, within

the range of the machine, must run to obtain various peripheral speeds.

For maximum economy in production, the feed of a drill should be all that its strength will permit without breakage, and the speed should be such as to necessitate sharpening at short intervals, say every twenty or thirty minutes; under ordinary conditions, it does not pay to run slow to avoid sharpening, as the cost of sharpening done by modern methods is so slight as to be negligible.

Adoption of Improved Design

In a recent conversation with a manufacturer who builds drilling machines among other things, it was suggested that there was considerable room for improvement in this line of machinery, and several of the features herein touched upon were discussed. While he admitted the general truth of the writer's contentions, he stated that if a machine embodying the suggested improvements were built there would be little or no market for it, as the price at which it would have to be sold to be profitable would be prohibitive; to 99 per cent of the buyers a 24-inch drilling machine is a 24-inch drilling machine and the manufacturer with the low price gets the business. Can this be true? Is it possible that the purchasing agent, with no knowledge of mechanics, is still allowed to influence the cost of production in many factories by dictating what machinery the shop must use, being governed not by efficiency but only by price? Is it possible that there are still business managers who will congratulate themselves upon having shrewd buyers when their saving of a sum on an original investment may mean the loss of five or ten times that sum in the increased production possible with the higher priced machine during its first year's use? If this is true, we need not hope for rapid improvement. It is the writer's belief, however, that there are many modern manufactories in which this condition does not obtain, and that the time is at hand when the machine of marked superiority will meet with a demand corresponding to its merits, irrespective of the higher price necessitated by the cost of its production.

* * *

SULPHUR AND PHOSPHORUS IN CASE-HARDENING COMPOUNDS

There is considerable difference of opinion among steel heat-treating experts in regard to the effect of the sulphur and phosphorus in granulated raw bone and charred leather on casehardened steel. Raw bone and charred leather contain phosphorus and sulphur. A metallurgical expert connected with a well-known manufacturing concern recently made a test to determine the infusion of sulphur into steel with charred leather, and he reported as follows:

Charred leather seems to be the most powerful casehardening compound for imparting sulphur to steel. A very careful analysis, checked independently six times, gave the following results in a casehardened steel of about 0.20 per cent carbon. Before treatment, the steel contained 0.020 per cent phosphorus and 0.042 per cent sulphur. After casehardening in charred leather it contained 0.020 per cent phosphorus and 0.217 per cent sulphur; in other words, if the steel were carburized clear through, the sulphur content was increased five times.

Raw bone and charcoal used for casehardening, on the other hand, made practically no change in the amount of sulphur or phosphorus content. This fact does not signify, however, that charred leather should never be used; but the amount of leather should be carefully estimated and kept below a content where it would impair the steel for the particular purpose intended. Leather is a rapid agent in carburizing, and I have used as much as 30 per cent of it in compounds with complete success. This, however, has been for steel sections where a little brittleness was not objectionable and hardness was the sole object sought.

For carburizing thin sections, such as inner and outer races for bearings, I prefer to keep the leather content about 10 per cent. The Fenerfeste Industrie Gesellschaft of Dusseldorf, Germany, however, has patented a compound purposely containing sulphur in the form of sodium sulphate to increase the rate of penetration, sulphur apparently acting as a vehicle in diffusing the carbon in the steel.

It will be readily seen, therefore, that a great diversity of opinion exists on this subject. In fact, it would be as unwise to condemn any particular compound or ingredient as it would be to condemn arsenic as a drug because it is a poison. A safe rule is to analyze a sample of steel before and after carburizing with a given compound.

PRESSURE DEVELOPED BY FRICTION SCREW PRESSES

AN ANALYSIS OF OPERATING CONDITIONS AT SUCCESSIVE STEPS IN THE CYCLE

BY FRITZ J. W. SPARKUHL*

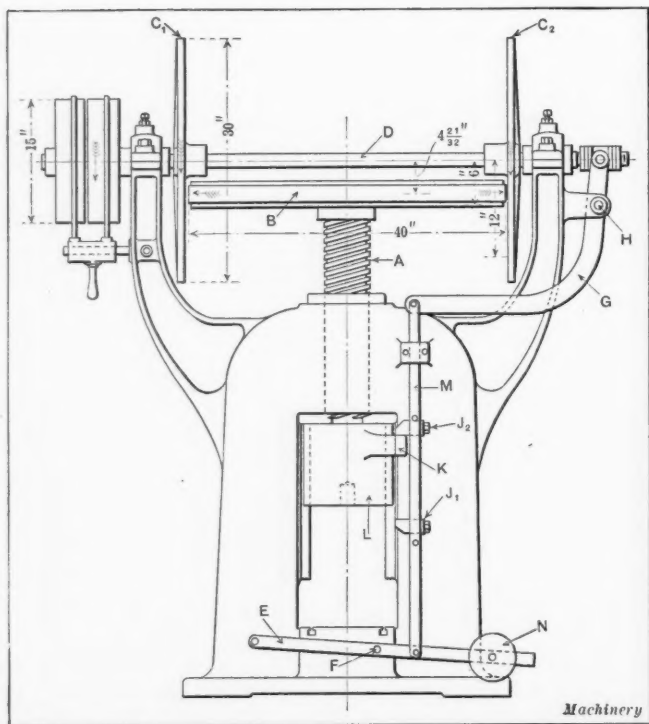


Fig. 1. Operating Mechanism of a Typical Friction Screw Press

THE great family of power presses includes one member which is almost a stranger in this country, *i. e.*, the friction screw press. Machines of this type are also called "percussion" or "spindle" presses, and have been used with unquestionable success in Germany and France for work for which drop-hammers and toggle embossing presses are commonly employed in this country. As the name "friction screw press" signifies, the motion is delivered to the ram by means of a friction drive, and the object of this article is to give a clear understanding of the operation of this drive in connection with a screw actuated ram. We know that a screw and nut are adapted for transmitting the power to the ram of a hand press on account of their simplicity of construction and the means which they provide for obtaining a much higher pressure at the ram than could be exerted by a foot press; for these reasons, the screw and nut principle on hand-operated machines finds frequent application in the construction of stamping, forming and embossing presses used in all branches of sheet metal work.

But when it comes to higher pressures and greater output, the hand press does not possess the required capacity, and a power-driven screw press must be used. This type of press is self-contained and works without shock or vibration so that it does not need a special foundation; and as it works almost noiselessly, and more quickly and accurately than a drop-hammer, it deserves a place in the list of metal working machinery as one of the most suitable equipments for many kinds of work. The ordinary crank or toggle press will not deliver the rapid and cumulative blow which is so essential for the proper performance of embossing operations; but with the reliable and sensitive controlling mechanism with which the friction screw press is equipped, the pressure can be regulated at will, so that the press makes an ideal machine for both the heaviest and finest classes of embossing and coining work. If double-action dies are employed, machines of this type are also well adapted for drawing tinware and other sheet metal products.

Fig. 1 illustrates a typical style of friction screw press. The spindle or screw A, Figs. 1 and 2, is made of tool steel with a pitch properly selected for the style of work to be done. At

the top, this screw carries a flywheel or friction wheel B which is of sufficient weight and size to store up the amount of energy required to perform the pressing operation. The face of this wheel is covered with a leather band which should be equipped with a suitable tightening attachment, thus insuring a rigid and perfect connection between the band and wheel, as the leather will stretch in the course of time.

By pressing either of the friction disks C₁ or C₂, which are keyed to driving shaft D, against wheel B, the disk motion is transmitted to the wheel. By depressing or lifting lever E which is fulcrumed at F, driving shaft D, with disks C₁ and C₂, is shifted horizontally through the action of lever G which has its fulcrum point at H. This can either be done by hand through the operation of lever E, by depressing foot-treadle I, or automatically by the engagement of adjustable dog J₁ or J₂ (see Fig. 1) against the projection K of slide L. This results in lifting or depressing connection M which joins levers E and G. The lower dog J₁ is set level with the top of the lower die and reverses the travel of the ram when stop K engages dog J₁. Similarly, upper dog J₂ reverses the travel of the ram when this dog is engaged by stop K. The counterweight N serves to facilitate the reversal of the machine. Fig. 2 shows an improved construction in which only the lower dog J₁ is required. With this design, a latch which acts upon the foot-treadle is released and forces either disk C₁ or C₂ into contact with wheel B through the action of spring O. It is evident that during the up and down motions of the screw and ram, the acting radii of friction disk C₁ or C₂ varies continuously, accelerating or retarding the motion of flywheel B, screw A and slide L.

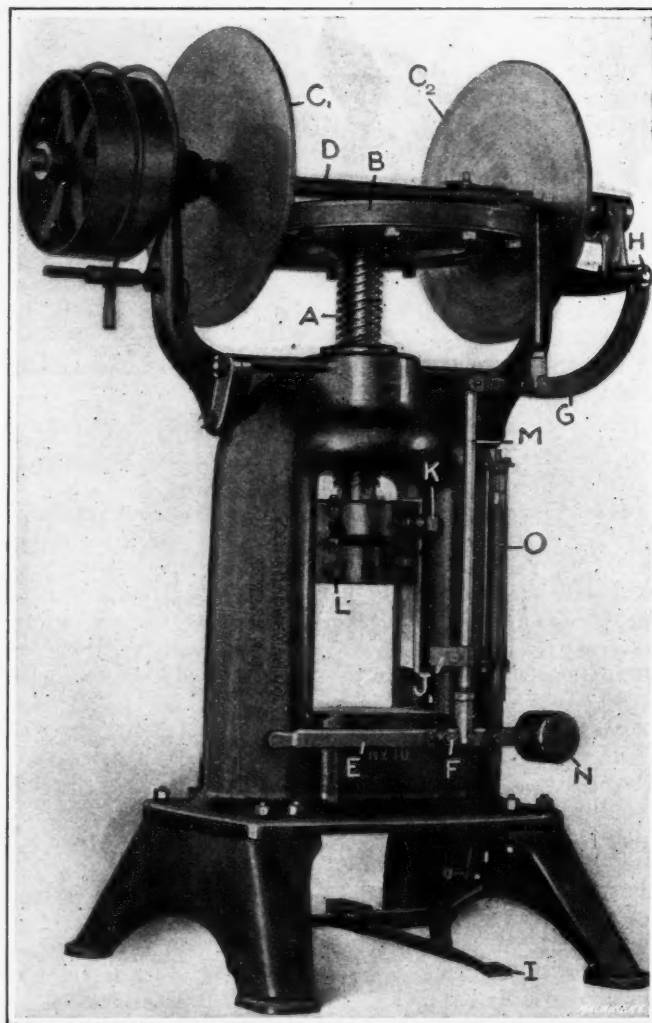


Fig. 2. Zeh & Hahnmann No. 10 Press which has a Capacity of 100 Tons

* Care of Coit Machine & Engineering Co., Irvington, N. J.

In the subsequent calculations the following notations are used:

n = R. P. M. of driving shaft D ;

P = force acting on face of flywheel B ;

W = combined weight of screw, flywheel, slide and tool;

M = mass of these parts = $\frac{W}{32.2}$;

p = pitch of screw;

R = radius of flywheel;

w_1, w_2 and w_3 = linear velocities of flywheel at different acting radii on friction disks C_1 or C_2 ;

x_1, x_2 and x_3 = different acting radii of disks C_1 or C_2 ;

f_1 = coefficient of friction for the screw threads;

f_2 = coefficient of friction for the thrust pivot;

r_1 = radius of screw;

r_2 = radius of thrust pivot.

The coefficient of efficiency N of the screw during the actual embossing action is given by the following equation:

screw turns until it comes to rest by a_1 , the amount of raising will be given by the following equation:

$$\text{Raising of screw} = \frac{a_1 p}{2\pi} \text{ inches.}$$

The amount of work required for raising the reciprocating parts is as follows:

$$\text{Work required} = \frac{a_1 W p}{2\pi} \text{ inch-pounds.}$$

The force P acting on the circumference of the flywheel uses up $a_1 P R$ units of work, and the flywheel, screw and slide come to rest when the conditions of the following equation are fulfilled:

$$\frac{N_1 M w_1^2}{2} = \frac{a_1 W p}{2\pi} + a_1 P R = a_1 \left(\frac{W p}{2\pi} + P R \right) \quad (2)$$

The center of the rim of wheel B is now at a distance from the axis of driving shaft D which is given by the following equation:

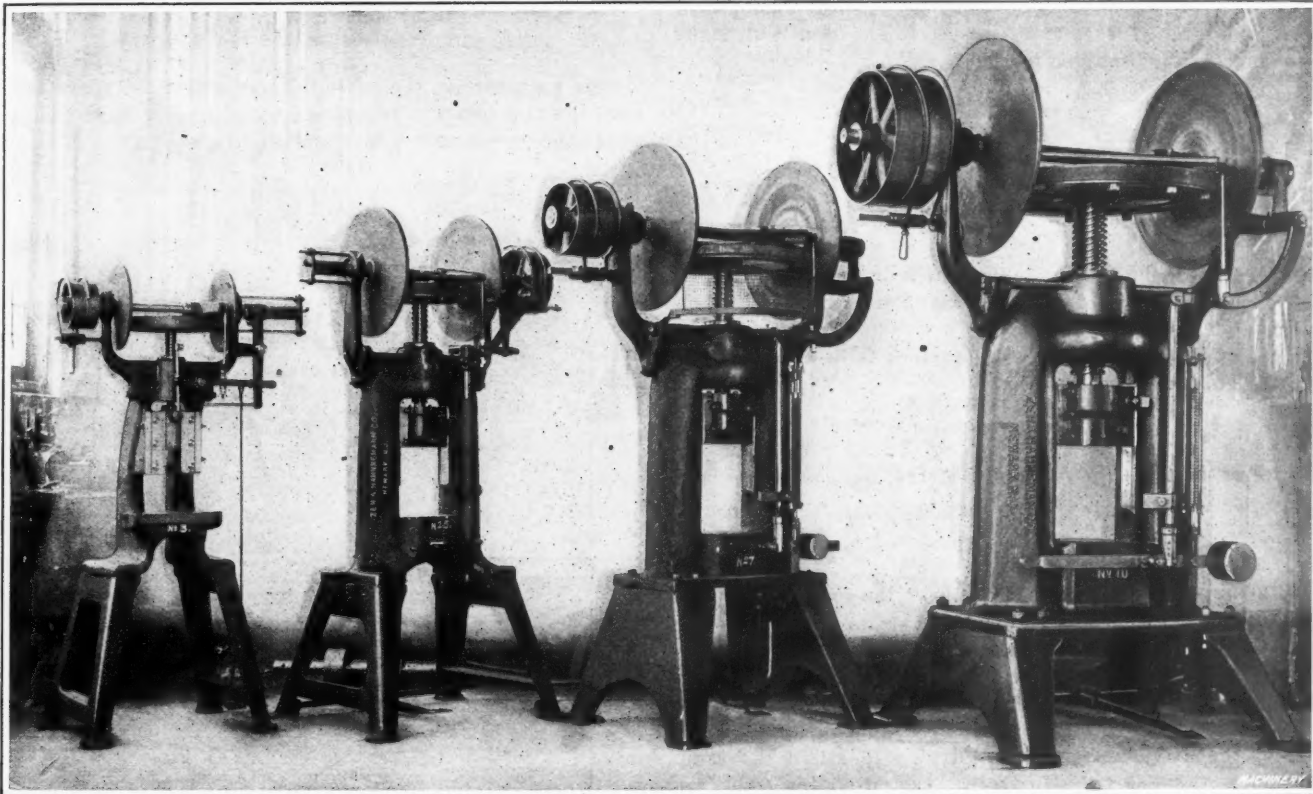


Fig. 3. Group of Four Zeh & Hahnemann Percussion Presses. The Complete Line includes Six Machines, each of which has a Capacity in Tons equal to the Square of the Size Number

$$N = \frac{m(1 - m f_1)}{m + f_1 + (1 - m f_1) f_2 \frac{r_2}{r_1}}$$

$$\text{where } m = \frac{p}{2\pi r_1}$$

At the moment that driving friction disk C_2 which raised the reciprocating parts is released (at a radius x_1 equal to the distance from the middle of the rim of wheel B to the axis of driving shaft D), and that friction disk C_1 is pressed against the face of wheel B , the linear velocity w_1 of wheel B is:

$$w_1 = \frac{2\pi n x_1}{60} \text{ feet per second.}$$

The total energy E_1 stored up in the flywheel B is given by the following equation:

$$E_1 = \frac{w_1^2 M}{2} = \frac{w_1^2 W}{2 \times 32.2} \quad (1)$$

This stored-up energy E_1 causes a tendency toward further raising of the screw, but the force P which is applied by disk C_1 serves to reverse the motion, and this force, together with the weight W of the reciprocating parts, counteracts the raising effect. If we denote the angle in radians through which the

$$\text{Distance} = x_1 - \frac{a_1 p}{2\pi} = x_2$$

The force P , acting in conjunction with the weight W , is now ready to give a downward motion to the screw and ram. The flywheel tends to assume the same velocity as driving disk C_1 , and as it was originally at rest a partial sliding action will occur between the friction surfaces, which will only cease when the velocities of the wheel B and disk C_1 are equal. The angle in radians through which the screw must turn until this state is reached is designated by a_2 , and the corresponding downward motion has the following value:

$$\text{Downward motion} = \frac{a_2 p}{2\pi}$$

The corresponding value of the acting radius x_2 on the disk is:

$$x_2 = x_1 + \frac{a_2 p}{2\pi}$$

The value of the linear velocity w_2 of the flywheel B for this acting radius is as follows:

$$w_2 = \frac{2\pi n x_2}{60} \text{ feet per second.}$$

For this velocity, the amount of stored-up energy E_2 in the flywheel has the following value:

$$E_2 = \frac{Mw_2^2}{2} = \frac{w_2^2 W}{2 \times 32.2} \quad (3)$$

Let x_1 denote the acting radius at the moment that the punch touches the work. The linear velocity w_2 is then found from the equation:

$$w_2 = \frac{2\pi n x_1}{60} \text{ feet per second.}$$

The value of the accumulated energy at this velocity is:

$$E_3 = \frac{Mw_3^2}{2} = \frac{Ww_3^2}{2 \times 32.2} \quad (4)$$

Let the distance which the punch travels from the moment it comes into contact with the work until the moment it comes to rest be denoted by t , during which time the screw has to turn through an angle α_2 in radians which has the following value:

$$\alpha_2 = \frac{2\pi t}{p}$$

The driving power P and weight W perform amounts of work equal to $\alpha_2 PR$ and Wt , respectively, from which the following equation may be reached:

$$N \left(\frac{Mw_3^2}{2} + \alpha_2 PR + Wt \right) = Qt \quad (5)$$

where Q = pressure on thrust pivot in pounds;

N = coefficient of efficiency.

$$\int Q dt = \int_0^t c t dt$$

where c is a constant, the value of which depends on the material in question, and this can only be obtained by observation and trial. If we assume that for a certain material the resistance offered to the travel of the punch is in direct proportion to the value of t , we have:

$$\int Q dt = \int_0^t c t dt = \frac{c t^2}{2}$$

If we assume that the resistance offered by some other material is proportional to t^2 , we have:

$$\int Q dt = \int_0^t c t^2 dt = \frac{c t^3}{3}$$

With the value of c obtained, we have the following expression for the pressure Q :

$$Q = c t \text{ pounds.}$$

Now the pressure P is released from the disk C_1 and applied to disk C_2 , the flywheel being at rest for a very short time with the center of the rim at a distance $x_1 + t$ from the axis of the driving shaft D and trying to attain the same velocity as the disk C_2 . Of course, a partial sliding action between the friction surfaces of these two wheels will take place, as their velocities are not the same, the condition being similar to that at the beginning of the down stroke. We find the angle α_1 , i. e., the angle through which the screw must turn until the sliding action ceases, from the equation:

$$N \left(\alpha_1 PR - \frac{\alpha_1 W p}{2\pi} \right) = \frac{Mw^2}{2R^2} \left(x_1 + t - \frac{\alpha_1 p}{2\pi} \right)^2 \quad (6)$$

During this time the spindle has risen through a distance given by the following equation:

$$\text{Rise of spindle} = \frac{\alpha_1 p}{2\pi}$$

The value of the acting radius x_2 is given below:

$$x_2 = \left(x_1 + t - \frac{\alpha_1 p}{2\pi} \right)$$

With this radius, the value of the velocity w_1 becomes:

$$w_1 = \frac{2\pi n x_2}{60} \text{ feet per second.}$$

The screw has the same velocity until reversing of the motion takes place at a radius of x_1 , and from then on the action of the press repeats itself as previously described. Carrying through a numerical example taken from actual practice, will assist the reader to understand the different phases of this subject.

Example: A friction screw press has a screw of $4\frac{3}{4}$ inches mean diameter, triple threaded with a pitch of 3 inches. The

diameter of the friction disks is 30 inches; the flywheel is 40 inches in diameter, and the press runs at 150 revolutions per minute. The pressure between the disk and flywheel is 57 pounds. The screw, flywheel, ram and tool have a total weight of about 1490 pounds, with a calculated mass M of 46.3. The reversing of the drive occurs at a point x_1 which is 6 inches from the axis of the driving shaft D , and the beginning of the pressing operation starts at a point x_1 which is 12 inches from the axis of the driving shaft.

Assuming the values $f_1 = 0.1$ and $f_2 = 0.08$ for the coefficients of friction of the screw threads and thrust pivot, respectively, we calculate a coefficient of efficiency during the period that the pressing operation is being performed, which is found to be 0.6, while for the idle running of the screw a value of 0.9 will be satisfactory. The velocity w_1 of the flywheel at the moment of reversal is:

$$w_1 = \frac{150}{60} \times 2\pi \times \frac{6}{12} = 7.86 \text{ feet per second.}$$

This gives the following value of the stored-up energy E_1 :

$$E_1 = \frac{46.3 \times 7.86^2}{2} = 1431 \text{ foot-pounds.}$$

Next we ascertain the angle through which the screw turns until the ram comes to rest at the top of its stroke. By substituting the proper values in Equation (2), we get:

$$0.9 \times 1431 = \left(\frac{1490 \times 3}{2\pi \times 12} + \frac{57 \times 20}{12} \right) \alpha_1$$

$$1289 = 154 \alpha_1$$

$$\alpha_1 = 8.36 \text{ radians}$$

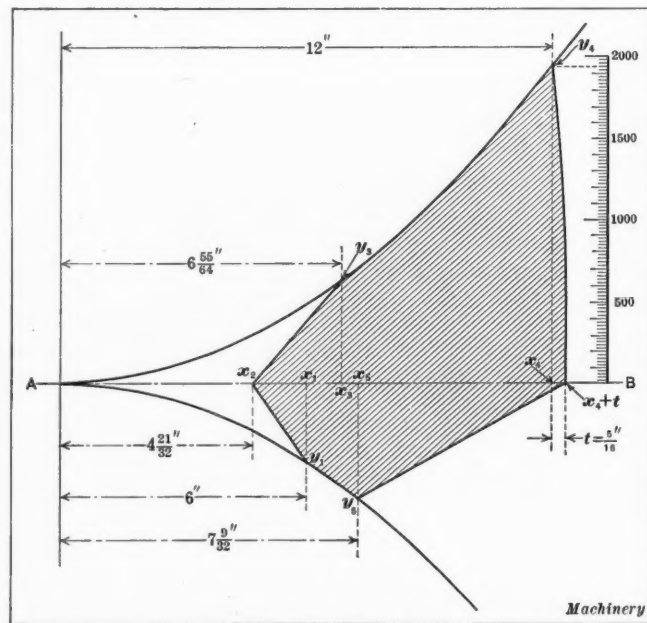


Fig. 4. Diagram showing Amount of Energy stored up in Flywheel at Different Points in Cycle

$$\alpha_1 = \frac{8.36 \times 360}{2\pi} = 479 \text{ degrees.}$$

This angle corresponds to raising the ram through a distance of:

$$\frac{3 \times 8.36}{12 \times 2\pi} = 0.332 \text{ foot.}$$

From the preceding calculations we arrive at an acting radius x_2 at the beginning of the down stroke, that is given by the following:

$$x_2 = 0.5 - 0.332 = 0.168 \text{ foot.}$$

The angle through which the screw turns until the sliding action between the driving disk and flywheel ceases, while the ram is descending, is explained by the following. Assuming a value of 1 inch for the downward motion of the ram before the slipping action ceases, and substituting proper numerical values, we have:

$$\text{Downward motion} = \frac{\alpha_2 p}{2\pi}$$

$$1 = \frac{a_2 p}{2\pi} = \frac{3a_2}{2\pi}$$

$$a_2 = \frac{2\pi}{3} = 2.09 \text{ radians.}$$

This value of a_2 corresponds with an angle of 119.5 degrees, which, by hypothesis, corresponds to a lowering of the ram of 1 inch = 0.083 foot.

The corresponding value of the acting radius x_3 is:

$$x_3 = x_2 + \frac{a_2 p}{2\pi} = 0.168 + 0.083 = 0.251 \text{ foot.}$$

At a radius of $x_1 = 12$ inches = 1 foot, the pressing operation starts; and at this moment the flywheel has attained a velocity of:

$$w_2 = \frac{2\pi n x_1}{60} = \frac{2 \times 3.14 \times 150 \times 1}{60} = 3.95 \text{ feet per second.}$$

For this velocity, the energy E_2 stored up in the flywheel is:

$$E_2 = \frac{Mw_2^2}{2} = \frac{46.3 \times 3.95^2}{2} = 361.5 \text{ foot-pounds.}$$

The acting radius x_4 at the time the punch engages the work was given as 12 inches = 1 foot. The corresponding value of the linear velocity w_3 is then found to be:

$$w_3 = \frac{2\pi n x_4}{60} = \frac{2 \times 3.14 \times 150 \times 1}{60} = 15.72 \text{ feet per second.}$$

The value of the accumulated energy E_3 at this moment is:

$$E_3 = \frac{Mw_3^2}{2} = \frac{46.3 \times 15.72^2}{2} = 5720 \text{ foot-pounds.}$$

Assuming that the work to be done by the press is of such a character that the distance t through which the ram travels from the time the punch engages the work until it comes to rest is $\frac{3}{4}$ inch, the corresponding angular movement a_3 of the ram is:

$$a_3 = \frac{2\pi t}{p} = \frac{2 \times 3.14 \times 0.75}{3} = 1.57 \text{ radian} = 90 \text{ degrees.}$$

The amount of work done by driving power P is:

$$\text{Work} = a_3 PR = 1.57 \times 57 \times 1.66 = 149.1 \text{ foot-pounds.}$$

The work done by weight of reciprocating parts is:

$$\text{Work} = Wt = \frac{1490 \times 0.75}{12} = 93.2 \text{ foot-pounds.}$$

Bearing in mind that the coefficient of efficiency N during the pressing operation is 0.6, we have from Equation (5):

$$N \left(\frac{Mw_3^2}{2} + a_3 PR + Wt \right) = \frac{ct^2}{2}$$

$$0.6 (5720 + 149.1 + 93.2) = \frac{c \left(\frac{0.75}{12} \right)^2}{2}$$

$$3577.4 = 0.001954c$$

$$c = 1,831,000$$

$$Q = ct = 1,831,000 \times \frac{0.75}{12} = 114,300 \text{ pounds} = \text{total avail-}$$

able pressure.

It will be of interest to show one cycle of operations of this machine in graphical form. On the horizontal line AB in Fig. 4, the points x_1, x_2, x_3, x_4, x_5 and $x_4 + t$ are all found by calculation and laid off. The ordinates erected at these points represent the corresponding stored up energies to a suitable scale. Starting with $x_1 = 6$ inches, the energy diminishes from y_1 to zero, which means that the flywheel has no energy left and comes to rest at its highest point. At $x_2 = 4 \frac{21}{32}$ inches, reversing of the flywheel motion takes place and a partial sliding action of the friction surfaces on the disk and flywheel is the result, until at $x_3 = 6 \frac{55}{64}$ inches, the wheel has assumed the same velocity as the disk, which is distinctly shown as the line of action falls on the parabola produced by plotting the various radii against corresponding values of the linear speed. At $x_4 = 12$ inches, the energy has increased to y_4 , and this energy is entirely given up at a radius of $x_4 + t$. Now the drive is again reversed; and a sliding action of the friction surfaces takes place until the point x_5 is reached. From y_5 to y_1 , no sliding occurs, as the velocities of the disk and wheel are

the same. At x_1 , the motion is again reversed and the cycle starts over again. If the diagram is laid out correctly, it affords an excellent means of ascertaining the amount of energy of the flywheel at any distance x_0 as the acting radius from the axis of the driving shaft, which would be represented by the ordinate y_0 .

* * *

VELOCITY OF STEAM FLOWING THROUGH VALVES

BY ERNEST A. ANDREWS, JR.*

The formula commonly used for determining the velocity at which steam flows through the ports or valves of an engine cylinder is:

$$V = \frac{AS}{P}$$

where V = velocity of flow through port in feet per minute;

A = net area of piston in square inches;

P = area of port or valve in square inches;

S = piston speed in feet per minute.

Assuming the value of the ratio $\frac{P}{A}$, or making use of this

value where it is known, the velocity at which the steam flows through a valve of area P may readily be found for any piston speed by referring to the accompanying chart. The vertical lines represent piston speed in feet per minute, and the hori-

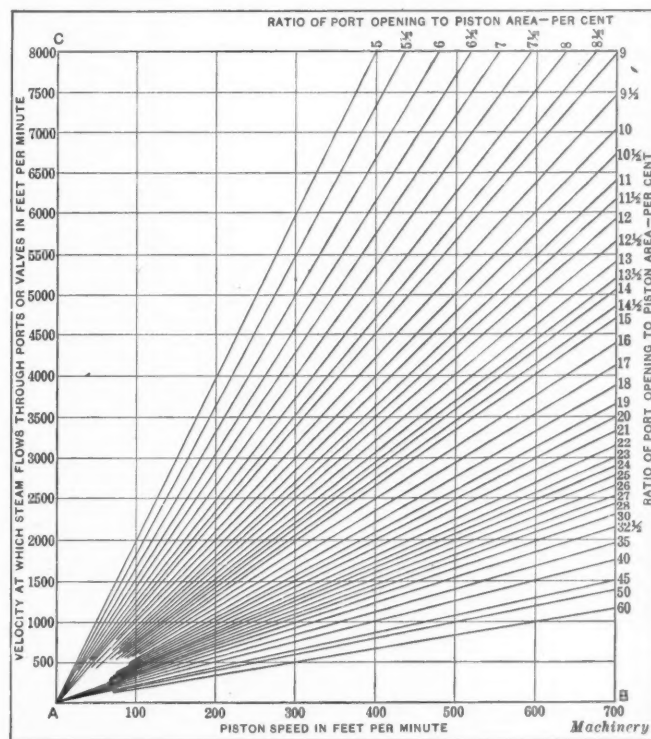


Chart for Use in determining Velocity of Steam Flow through Valves

zontal lines, velocity at which the steam flows through the valves in feet per minute; the radial lines indicate different

values of the ratio $\frac{P}{A}$ expressed in per cent.

To illustrate the use of this chart, consider a case in which the valve area P is 14.7 square inches, and the net piston area A is 113 square inches. Then the value of ratio $\frac{P}{A} = \frac{14.7}{113} = 0.13$;

or area P is 13 per cent of area A . Using this value, and assuming that the piston speed S is 500 feet per minute, we locate this value of S on the base line AB and follow the vertical line at this location until it crosses the radial line indicating the ratio of 13 per cent; then follow the horizontal line from this intersection across the chart to the left-hand margin, where the required velocity of the flow of steam through the valves is found to be 3850 feet per minute.

* Address: 1308 Franklin Ave., Bond Hill, Cincinnati, Ohio.

FORMING SHEET METAL BY THE ROLLING PROCESS

The forming of sheet metal strips by the rolling or channeling process was described in the February, 1916, number of

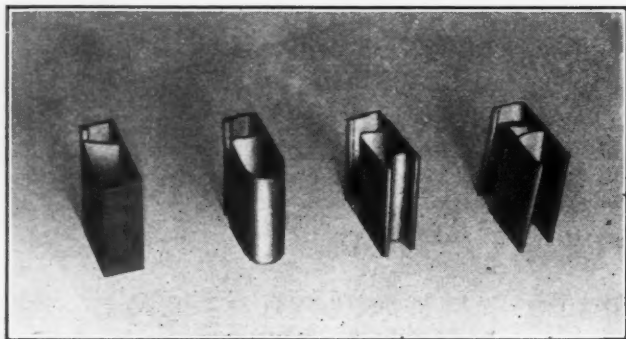


Fig. 1. Sections of Sheet-metal Molding formed by rolling

MACHINERY. A very difficult job of this kind is the production of sheet steel strips of the sections illustrated in Fig. 1 for use as window screen runners. In each case the metal is 0.018 inch thick and the formed strip is 7/16 inch wide and 1 inch deep. The machine for doing this work is shown in Fig. 2. It receives the flat stock at one end and delivers it, completely formed, at the opposite end.

Briefly, this metal-forming operation consists in feeding the metal strip between seven pairs of forming rolls, each of which gives it a slightly more advanced shape than that imparted by the preceding pair of rolls. As shown in Fig. 2, the machine is driven by a pulley at the side, which carries rotation through an intermediate shaft to the lower roll at the center of the seven sets of rolls. Each of the lower rolls is connected with the others by means of intermediate spur gears, and as each upper roll is geared to the lower roll, it will be seen that rotating the main driving shaft causes all of the rolls to turn in unison. In Fig. 2 the machine is shown with the gear guards removed to expose the gearing.

The roll shafts are mounted in pillow blocks and the blocks of the upper and lower shafts of each set are kept normally separated by spiral springs. In order to give the desired pressure on the metal, set-screws are provided over each of the roll bearings that may be adjusted so that the metal may be pressed flat while being formed.

In Fig. 3 a top view of the seven sets of rolls is shown. The metal enters the machine from the left, being guided at the sides by gages that keep the strip centered. After leaving each pair of rolls, the metal is guided by a pair of steel strips that insures it entering the next pair of rolls properly.

The sequence of rolling operations on a section of the kind shown in Fig. 1 is illustrated in Fig. 4, from which the amount of work performed by each pair of rolls can be seen. The rolls are made of low-carbon steel, cyanide-treated and hardened in oil. Referring to Fig. 4, the work performed by the first pair of rolls *A* is rough-shaping the steel strip to start the metal flowing in the right direction. The bends are accentuated by the second pair of rolls *B*, and in the third pair of rolls *C* the metal begins to take shape. The function of the first three pairs of rolls is to manipulate the metal into the right position for forming the deep grooves, which is the most difficult part of the work. The work done by the fourth pair of rolls *D* is the forming of the ends of the section, so that the last three pairs of rolls have only to "assemble" the shape.

This assembling operation is started in the fifth pair of rolls *E*. These force the sides of the strip that form the ends of the section inward toward their final position, and in this pair of rolls, the central slot or cavity is finally finished. The sixth and seventh pairs of rolls *F* and *G* complete the rolling in of the sides of the strip. The seventh set of rolls completes the closing together of the sides and at the same time flattens down and smooths out the corners, insuring that they are of the right degree of sharpness and squareness. After leaving the rolls, the strip is run through another machine that closes in the edges, so that one edge is locked around the opposite edge, as shown in Fig. 1. This machine was not really necessary, as the operation could just as

well have been included in the first machine if the designer had so desired. The machine for doing this work is about five feet in length, and weighs approximately 1300 pounds. The

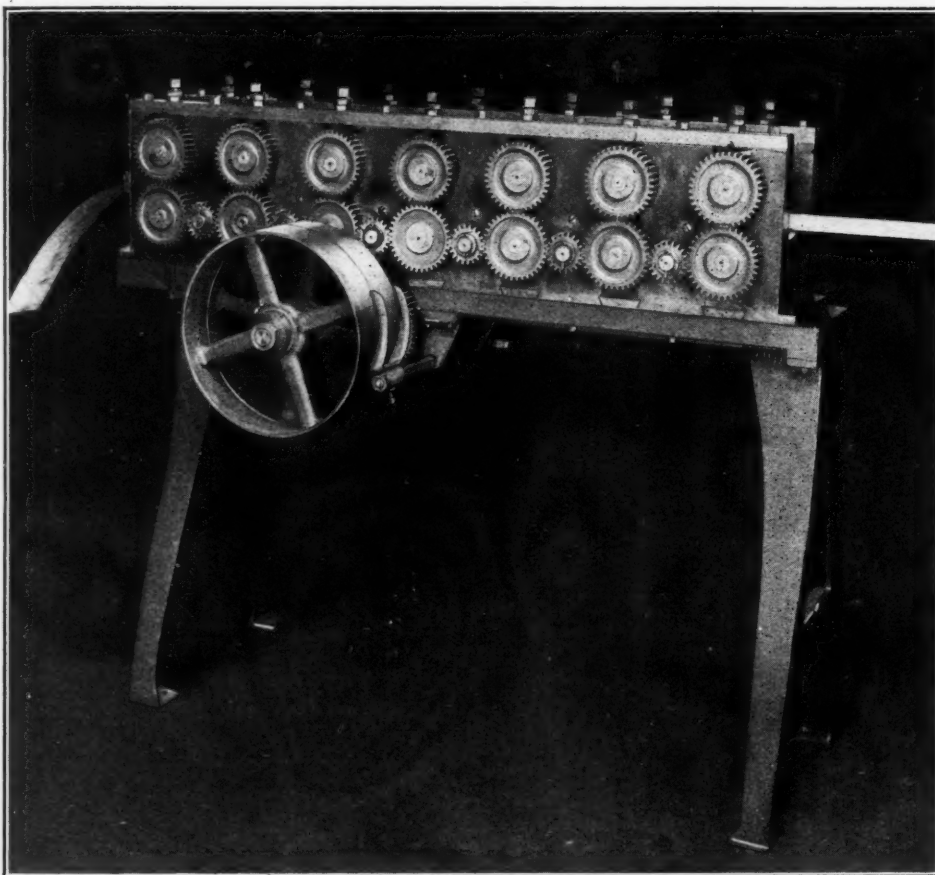


Fig. 2. Cadwell-Vernon Sheet-metal Rolling Machine

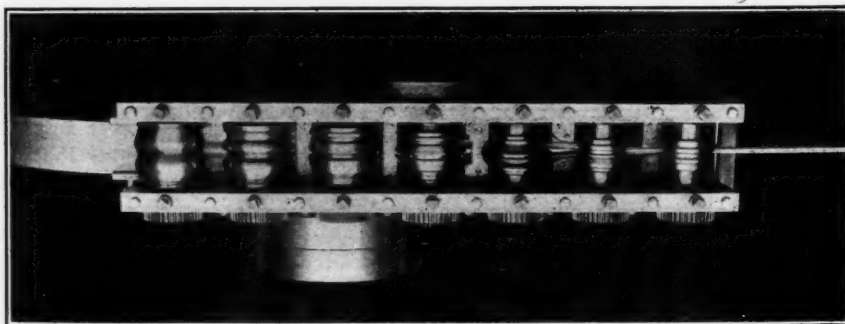


Fig. 3. Plan View of Machine, showing Rolls

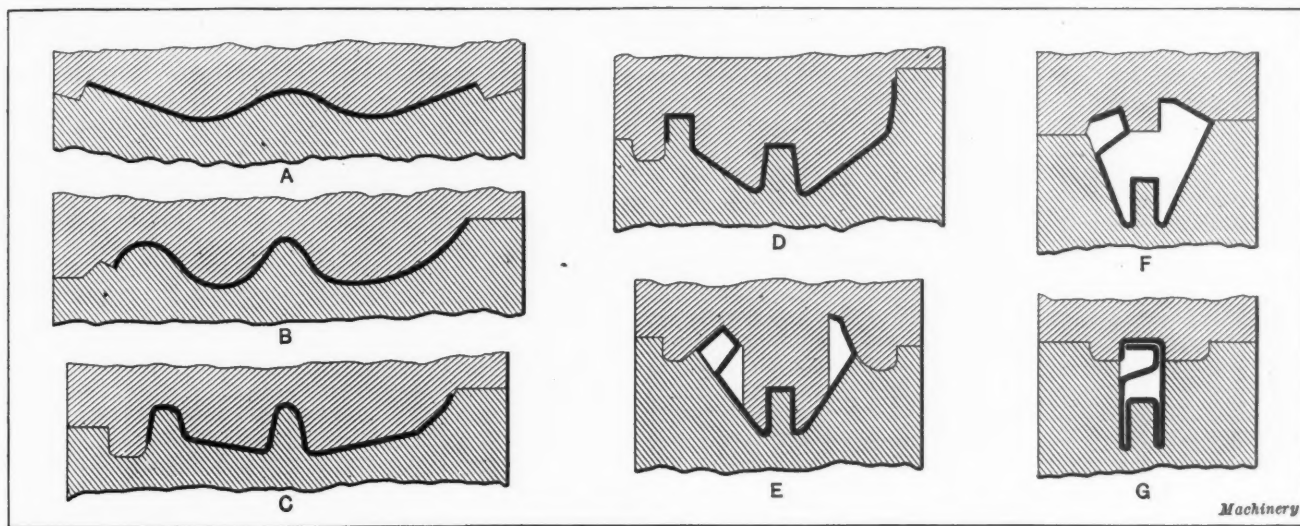


Fig. 4. Diagram showing Progression of Metal through Rolls

amount of power required for driving is very slight; in fact, it can easily be operated by hand, and when power-driven a 2-inch belt can be used.

When these strips were made by the use of presses and dies, eight operations were required, and there was a limit to the length of strip that could be produced. With this rolling machine, the length that can be produced is unlimited, and the finished stock emerges from the machine at the rate of twenty-five feet per minute. A slight lubricant is applied to the stock to keep the surface in good condition. By fitting the machine with different rolls, it is possible to produce almost any shape of molding or metal section.

This machine was built by the Cadwell-Vernon Co. of Jamestown, N. Y., which has made a specialty of sheet-metal forming by rolling. Patents of the machine are pending in the United States and Canada.

C. L. L.

THE TECHNICAL PRESS

BY A. L. HAAS*

The functions filled and the interests served by a paper like *MACHINERY* are manifold. Its readers are in occupations which are as wide as the entire mechanical engineering field. Everyone directly—or for that matter indirectly—connected with the trade can find interest and profit from its perusal. There is no man, whatever his position, who does not lose ground unless he reads at least one technical periodical to keep himself informed in regard to new ideas and practice. As a supplement to a restricted field, it possesses a value not to be lightly disregarded.

Access to every text-book printed or to an ideal reference library does not substitute or do away with the necessity for a live technical periodical. The mental effort needed to swallow large treatises is considerable, and it may be said that in most instances they are shelved for reference purposes. If the information contained came in monthly "doses" the effort needed to digest the contents would be considerably lessened. This does not in the least belittle the field an authoritative book serves, but the serial aspect of a technical journal gives it a great advantage as a purveyor of knowledge. Systematic reading of a paper like *MACHINERY*, together with the preservation of articles in which the reader finds interest, will at a small cost build up a library of technical information obtainable in no other manner. Unlike a text-book, the matter so obtained has been pre-digested before filing away, and has made for itself a memory, so that mental effort is lessened when consultation is needed.

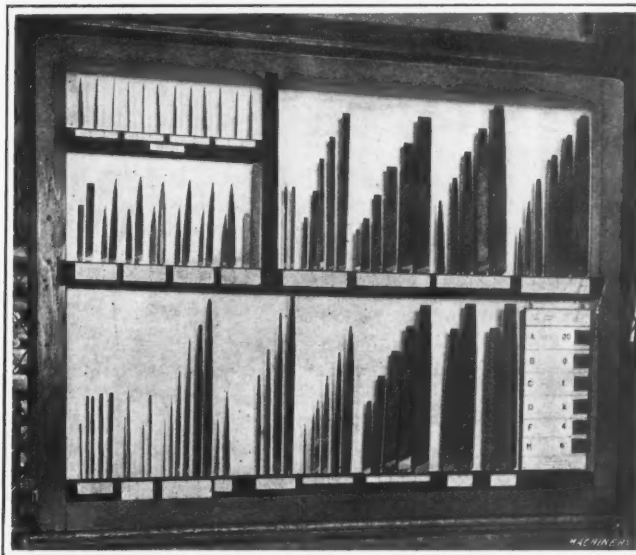
If the "make up" of *MACHINERY* be examined, it will be found that the question of preservation of the more important articles is duly considered by the editor. Almost any issue will readily subdivide for filing. The man who reads a live technical journal regularly is less provincial and has broader views and a wider mental horizon than one who does not. He sup-

plements his restricted field or specialized task by fuller comprehension. Even casual reading of matter not directly or remotely bearing upon the reader's work stimulates his faculties and helps to broaden the particular corner in which he is confined, making him feel the brotherhood of craft. This indirect benefit is probably even greater than a direct solution of a reader's difficulty. The bond created between a good technical journal and its readers is of a particularly intimate nature, and is dependent upon both paper and reader. It is a mutual service that is rendered, the dependence of the paper upon its readers consisting in the information and help afforded by the passing along of experience.

* * *

SAMPLE BOARD FOR FILES

The Cadillac Motor Car Co. of Detroit, Mich., recently came to the conclusion that many of the men in its shops were working at low efficiency owing to lack of knowledge concerning the names of different types of files. In many cases it was thought probable that the man knew what kind of file he wanted for his work, but in ordering it from the attendant in the tool supply room, wrote the wrong name on his requisition slip. Then when the file was given to him, he did not wish to admit his error and so took it out to the shop and did the best work he could with it. To overcome this difficulty, a sample board has been placed outside the window of each tool supply room on which there is a complete set of files with the proper name under each file. With this system in use, the workman comes to the tool supply room and looks at the board to determine the right name of the file that he wants before handing in a requisition slip. As a result, he is sure to get the proper file for his work. E. K. H.



Sample Board placed outside Tool Supply Room Window for Guidance of Workmen in ordering Files

* Address: 146 Crowborough Road, London, S. W., England.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

FRICTION, HEAT AND WEAR

The engineer of a well-known firm of ball bearing manufacturers was recently called in to confer with the engineer of a coal mining corporation concerning the suitability of ball bearings for installation in machinery used at the mines. In outlining the requirements of his company, the mining engineer said that the feature of low friction losses in ball bearings was not a point that interested him particularly, because he was able to obtain fuel at such a low cost that increased mechanical efficiency was of minor importance. "What we want," said this engineer, "is a bearing that will not give trouble from heating, and that will have a sufficiently long life to reduce expenses from shut-downs to a minimum."

A little thought will show that this man had overlooked the fact that friction, heat and wear are interrelated phenomena, and that when one appears it is a sure indication that the other two are present. The experienced millwright who finds a bearing with a tendency to become heated immediately proceeds to look for the cause, because he knows that the bearing is consuming an unnecessary amount of power and is wearing excessively.

* * *

DESIGNING MACHINERY TO BE ACCESSIBLE

It is one thing to design a machine that will function correctly and quite another to design one that will function correctly and that still can be readily erected and repaired. The theoretical designer may be quite competent to design a machine that will perform its function so long as everything is working right; but when repairs are needed there is trouble for the repair man. He may find that half the machine must be torn down to get at the worn part requiring repair or renewal. An erector who had years of experience says:

The writer is an erecting machinist at present engaged in erecting two machines which were never designed—they were simply thrown together haphazard. The situations found are almost beyond belief. Many times the parts that must be adjusted are so made and located as to render such adjustments all but impossible or involve the dismantling of several hundred pounds of parts where it should not be necessary to take any apart. Hours and days must be spent to accomplish what could have been done in a few minutes had the machines been properly designed. I

have been erecting machinery for ten years for concerns of international fame, but never have I found such a variety of impracticable constructions as now confront me. Of course the erecting man is in a poor position to object. He is the last in the line of men and has to take whatever is handed him, for he cannot pass it on to the next fellow. Corrective work in the field, however, costs high, and it would seem as though the common kinds of mistakes so frequently met with could be prevented by intelligent supervision in the drafting-room or shop.

The remedy for such conditions as are briefly described in the foregoing is to insist that every machine designer shall consider accessibility an important feature of design. Perhaps the best way to impress that idea on designers would be to give everyone a taste of erecting and repair work before he is allowed to do independent designing.

* * *

RECORDING ENGINEERING QUALIFICATIONS

An interesting investigation is being carried on at the present time to determine the relationship between the records of a student's work in an engineering college and his actual qualifications in practical engineering work. This investigation is now possible because some of the largest industrial concerns in the country, where hundreds of engineering graduates have received their first practical training, are keeping records of the manner in which they perform their duties. In each department where these young men are employed, the man in charge gives the graduates certain marks for accuracy, diligence, punctuality, general character, inventive ability, etc. If the student works in a number of departments, the various marks for each qualification are added, and the average is recorded as a fair estimate of his personality and ability; this record is used in the future in determining the kind of work for which the young engineer is best fitted, and, of course, also for deciding whether or not he should be permanently employed by the concern. The investigators who have compared the standing of students at the universities or the engineering colleges with their performance in practical engineering, have been given access to these records kept by industrial firms, and it is said that interesting conclusions have been drawn from these comparisons. When the investigation is completed, the results will be published.

An interesting fact stated in this connection is that the investigators have found that different colleges develop to a very marked degree different qualifications in the student; and it is said that those institutions which are highly organized with a strong man at the head and of somewhat military regime, turn out students that score higher in accuracy than in inventive ability, while those institutions where the leadership is weaker and the regime less rigid show a higher percentage in the development of originality and of the inventive faculties. These investigations should be of value in determining the lines along which educational institutions should develop in order to best educate young men to meet the requirements of practical engineering. The investigations will show clearly what qualifications are the most valuable in engineering work outside of the college, and will give the educators a basis on which to develop courses that will meet the requirements of the industries. The rating of a student in his college studies and that which is given to him by his first employer ought to show some similarity. If it does not, the engineering school is placing too high a value on certain qualifications which future employers do not esteem very highly; and on the other hand, it neglects those qualities which in practical work count for more. This condition can be improved only by such thorough investigations as are now being made. The educators, once informed of the mistakes made in the past, can begin to shape new policies which will meet the demands of the industries more satisfactorily.

* * *

The need for efficiency which has been so loudly proclaimed throughout the country for several years has had a great deal of influence on shop organization, but it has hardly been heeded at all in the financial and selling ends of business, where it is needed worse than in the shop.—H. L. Gantt, in *Industrial Leadership*.

RATING OF PUNCH PRESSES

The rating of power punch presses is a matter upon which practically no two manufacturers agree. Some rate their presses by number, the number used bearing a certain relation to the diameter of the crankpin. For instance, when a flywheel press has a crankpin, say, 5 inches in diameter, the rated capacity is the square of the diameter, or 25 tons pressure. This practice is followed by the E. W. Bliss Co., but the number given to the press does not always indicate its capacity, which depends, to a certain extent, upon the gearing. Other manufacturers use the diameter of the flywheel and its maximum velocity as a basis upon which to rate the capacity of the press. Zeh & Hahnemann Co. uses a number, the square of which is the rated capacity of the press. For instance, a No. 5 press is capable of exerting a pressure of 25 tons.

The Standard Machinery Co.'s practice is to calculate the diameter of the crankpin in practically the same manner as for a beam supported at both ends, the cross-section of the crankpin being determined by what the tonnage would be at the dead point. In other words, the dead point tonnage is used to indicate the tonnage of the press. By this method, however, the tonnage has no direct relation to the number given, which is chosen arbitrarily.

The Niagara Machine & Tool Works divide their presses into series according to tonnage and general construction. The first one or two figures of the press number indicate the series, and the last, the drive used on the various machines in the series. All presses whose numbers end with the same figure have the same drive; for instance, a No. 4, 14, 34, 44 and 54 all have a No. 4 drive. The ram pressure exerted by the smaller presses—up to 100 tons capacity—is approximately equal to the square of the number indicating the drive. For example, a press with No. 4 drive would exert a pressure of 16 tons. This rule is not used by this manufacturer on presses of a capacity greater than 100 tons per square inch.

The Ferracute Machine Co. divides its presses into series and classes. The series is indicated by a letter and the class by a number, which also indicates the capacity of the press in tons, the final figure showing the position in the series. For instance, a press classified as "S-204" would be a stamping press with a capacity of 200 tons pressure, fourth size; a throated stamping press of the same capacity would be "ST-204"; and a double-acting stamping press with a throated column would be "STD-204." This system, however, is not followed universally by this manufacturer, distinction being made between standard and special presses. In special presses, the number is no indication whatsoever of the ram pressure exerted by it.

The Toledo Machine & Tool Co. rates the nominal capacity of the press in tons as equal to three and one-half times the square of the diameter of the crankpin. For instance, a press having a 2-inch diameter crankpin would exert a pressure of 14 tons. These ratings are based upon experiments as well as calculations and are for an average material, such as 0.45 per cent carbon steel crankshafts. These pressure capacities only hold true for limited strokes of the slide and where these strokes do not exceed the diameter of the shaft; in cases where the strokes are greater than the diameter of the shaft the torsional stresses to which the shaft is subjected have a material influence upon the pressure capacity. The preceding remarks apply only to shafts that are driven from one end; if a shaft is driven from both ends the pressure that would be exerted would be double that secured through a single driveshaft. Another factor affecting the capacity of a press is the period through which it operates and the point at which the pressure is to be exerted. A flywheel press can only exert the pressure at the bottom of the stroke. If the pressure has to be continued for some period or through a certain distance gearing must be resorted to.

The American Can Co. rates the nominal tonnage of the press from the strength of the frame and crankshaft, and establishes a standard stroke; any increase in the stroke changes the capacity of the press. In cases where it is necessary to use the blanking dies absolutely flat, as, for

example, in blanking such work as armature disks, a press should be selected which will exert a considerably higher pressure than that required to blank a piece of the same size when a shear can be used on the punch or die. In blanking dies having no shear edge, the strain on the press comes at one point, and is not gradual, as is the case when the die is sheared.

In the absence of any accepted standard of press rating, the Baird Machine Co. has adopted the conventional method of using arbitrary numbers for its line of presses. This concern obtains samples of the work to be done and turns them over to the engineering department for study and consideration. In determining the size of press required, the tooling method is always taken into consideration. Actual tests are then made to determine the pressure required to perform the operation.

In numbering open-back presses, the Waterbury Farrel Foundry & Machine Co. uses an arbitrary system, which dates back to the beginning of the use of presses in the Waterbury district. For instance, a No. 2 or a No. 3 press means a press of approximately a certain weight with a crankshaft and flywheel of a certain size. A No. 3½ press is practically the same as a No. 3 machine, except that it has a longer frame, suitable for a longer stroke. Practically all open-back presses are numbered by the sizes of the shafts and flywheels.

The pillar line of presses manufactured by this concern is rated in a different manner. In this case, the number of the press is obtained by dividing the cross-section area in square inches in one upright by 10; hence, a No. 2 press has 20 square inches in one upright. This rating is based on the assumption that the tension is 2000 pounds per square inch of section, so that a No. 2 press would be capable of exerting a pressure of 80,000 pounds, or 40 tons.

Toggle presses are rated according to capacity, the capacity being determined by the pressure required for doing the same work on a hydraulic press, as indicated by a pressure gage. For example, suppose that the maximum capacity rating of a toggle press is 100 tons; this means that the press will perform an operation requiring a total pressure of 100 tons in a hydraulic press, measured by the gage. It has been the experience of the Waterbury Farrel Foundry & Machine Co. in designing and selling presses that a rating according to tonnage is absolutely valueless from the standpoint of the customer. Unless the customer knows what unit strain was allowed for in making this rating, there is no basis of comparison. The only safe figure to give is the total weight of the machine, diameter of the crankshaft and weight of flywheel.

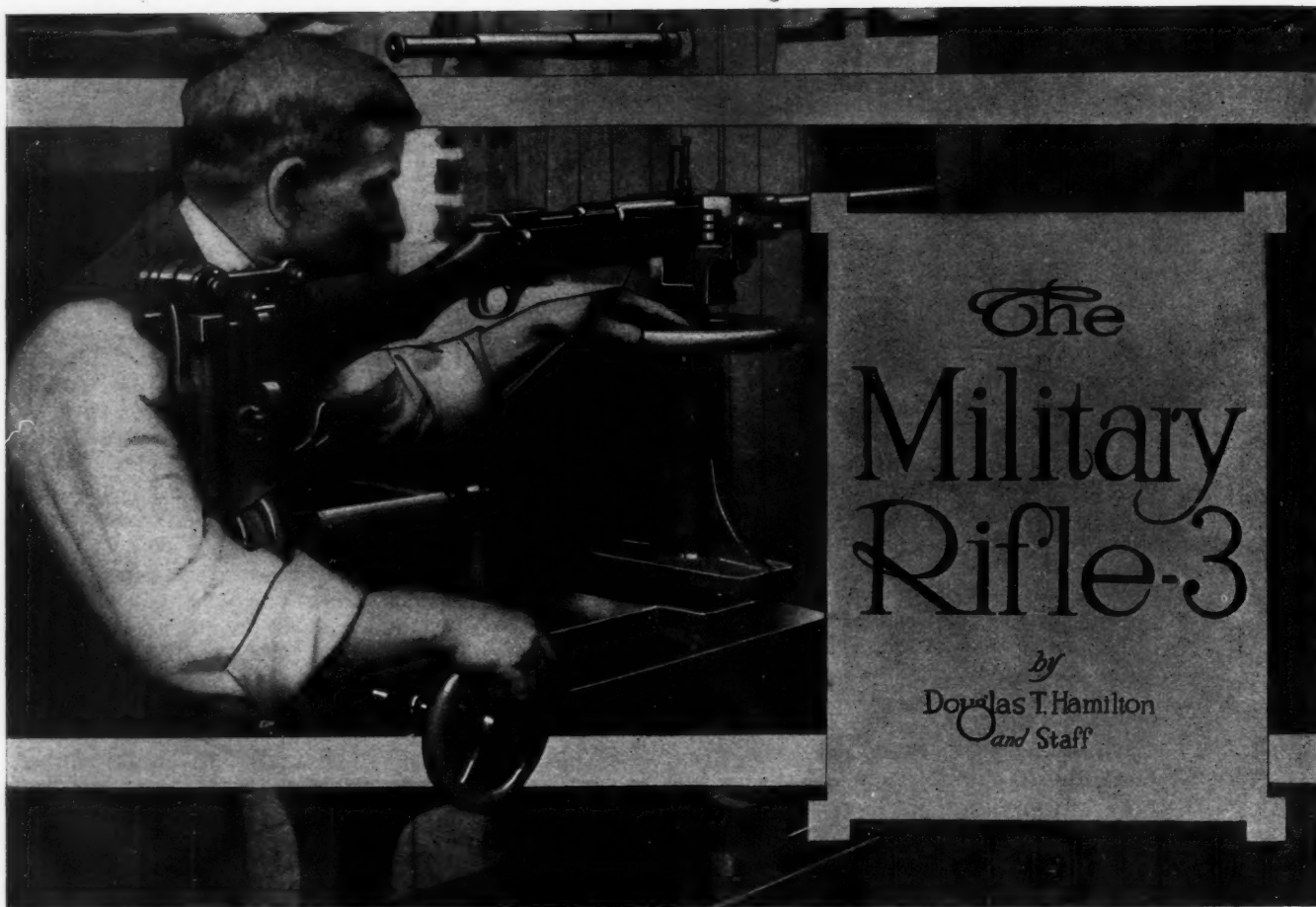
D. T. H.

* * *

TAKING PHOTOGRAPHS IN SHOPS

A photograph of a shop interior with the men working, in natural poses, is extremely difficult to secure. In the first place, it is generally necessary to give long exposures or to use a flashlight if an instantaneous exposure is made. In the second place, it is hard to get workmen to act naturally when a photographer is around. Their impulse is to face the camera and strike an attitude. This defeats the object of taking a shop interior, especially when it is desired to show processes or the manipulation of machines. It is sometimes necessary for the photographer to resort to a trick in order to get the result wanted. He apparently takes the picture, and then tells the men to resume their places, whereupon he makes the exposure and secures the natural effect desired—perhaps.

If workmen would consider what the object generally is when a photographer appears in their midst, they would concentrate on their work the same as usual, and not pose. If they gave proper consideration to the matter, they would realize how ridiculous it is for men in working clothes, in the grimy atmosphere of a shop, to have their pictures taken at attention. Let the workman attend to his job, and the photographer will be all the better pleased, and he himself will be better pleased when he sees the photograph; it will appear more to his credit if he seems to be working as usual, and not standing with the expression on his face: "Here I am; ain't I handsome?"



THE preceding installments of this article, published in the April and May numbers of *MACHINERY*, described step by step the machining operations on the parts of the Spanish Mauser military rifle. The principal parts treated were: the barrel, receiver, bolt, magazine and trigger guard, and rifle stock. In this installment the assembling and testing operations on the Spanish Mauser military rifle are taken up, and the equipment and number of operators required to turn out and assemble 200 military rifles in eight hours is specified.

ASSEMBLING AND TESTING OPERATIONS ON SPANISH MAUSER MILITARY RIFLE

The assembling of a military rifle is generally done on the unit group system similar to that adopted by the leading machine tool builders. The various components of the rifle are divided into groups, such as the barrel and assembly, receiver assembly, bolt assembly, magazine and trigger guard assembly, stock assembly and miscellaneous parts. With the layout suggested in the preceding installments, all the machining operations should so complete the parts that no filing or fitting is necessary. There are cases, however, where a slight touch of the file is necessary to remove the upset edges, particularly on soft parts, which have been caused by the parts receiving improper handling during transportation from one department to another. Various methods are used for transporting the work throughout the plant, and arranging it in the most convenient order for the assembler. Probably the most advanced method is to use the truck or conveyor system, and have an open aisle running down the length of the assembling floor. The parts are

handled on the conveying gravity system or by wheel trucks, and held on benches before the assembler. For additional details on machines and fixtures used and production, see Table XXXIX.

Operation 1: Barrel Proof Test.—This test is made on every barrel previous to browning, by using an overcharged cartridge, capable of producing a maximum chamber pressure one-third greater than the maximum pressure obtained with a regular service cartridge. Before making this test it is the practice of some governments to assemble the sight bases, and also to leave the cartridge chamber 0.002 inch smaller than the finished size. For proof testing, the barrel, receiver and bolt are assembled, the action being completed with "standard" components used for that purpose. The barrel is clamped rigidly in a special fixture, and the tester is protected by having the testing device enclosed in a heavy shield. After testing, the barrel, receiver and bolt are examined to see that they are sound. The chamber is then reamed to the required size in a hand reaming fixture.

Operation 2: Tin Seats on Barrel for Front and Rear Sight Bases.—This consists in depositing a low melting point solder on those portions of the barrel where the sight bases are to be located.

Operation 3: Press on and Sweat Rear and Front Sight Bases on Barrel.—In performing this operation, the barrel is held in a special fixture in such a manner that the registering point previously marked to line it up with the receiver is located definitely. Then the sight bases are located in relation to this mark by a special device in the fixture. Operating handles are then moved to force the sight bases on the barrel, after which a bunsen burner is applied to the barrel until the

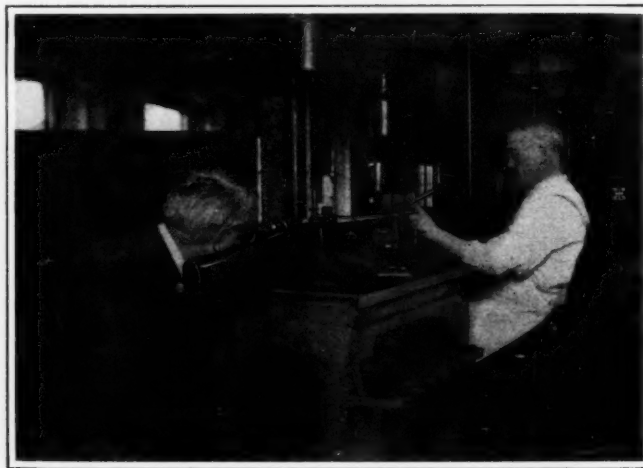


Fig. 67. Setting the Sights in Line with the Axis of the Barrel

solder paste is melted. The burner is then removed and the solder allowed to set before removing the barrel.

Operation 4: Drill and Countersink Locking Screw Holes in Sight Bases.—This operation is accomplished on a two-spindle sensitive drilling machine, using a special fixture for holding the barrel. A combination drill and countersink is used.

Operation 5: Fit and Assemble Front Sight.—This is a bench operation, and consists in fitting the front sight into the slot in the front sight base. As the front sight must be a good driving fit in the base, it is left a little large and then fitted to drive in. The operator simply locates it in approximately the correct position, as it is located accurately in a subsequent operation.

Operation 6: Fit and Assemble Rear Sight Leaf Spring, Leaf, Slide, and Catch.—This is also bench work and consists in first fitting the leaf spring in the rear sight slide base, then putting in the screw, then fitting the leaf to the projections on the sight base and driving in the fulcrum pin; after this the slide is fitted to the sight leaf and the stop screw inserted in the top right-hand corner. The slide catch is then fitted and the pin driven in. These parts must work freely when fitted in place.

Operation 7: Assemble Sear and Trigger.—This consists in simply putting the trigger in the sear slot, driving in the trigger pin and then inserting the sear spring. As all of these parts have been hardened, no fitting is necessary.

Operation 8: Fit and Assemble Retaining Bolt.—This consists in fitting the retaining and ejector bolt spring into the retaining bolt body, inserting the ejector and trying the fulcrum screw in the threaded hole.

Operation 9: Assemble Sear and Retaining Bolt to Receiver.—This consists in putting the sear over the fulcrum point on the receiver and then driving in the pin, and in doing the same with the retaining bolt, except that a screw instead of a pin is inserted. No fitting is necessary because all parts have been hardened.

Operation 10: Fit and Assemble Extractor and Extractor Collar to Bolt.—This operation consists first in expanding the extractor collar and placing it over the groove in the bolt, then locking the projections on the extractor collar into the corresponding locking grooves in the extractor and moving it back and forth to see that it operates freely.

Operation 11: Assemble Striker, Main Spring, Bolt Plug, Safety Lock and Cocking-piece to Bolt.—This consists first in putting the main spring on the striker; then the striker is held in a special fixture and the bolt plug forced on to compress the main spring. The cocking-piece is then put on and given a half turn, locking it in position. Before the cocking-piece is put on, however, the safety lock must be put in place in the bolt plug. This assembled member is then placed in the bolt and the bolt plug screwed into the end of the bolt and brought into proper alignment. As all of these parts have been hardened, no filing should be necessary.

Operation 12: Assemble Bolt to Receiver.—This operation consists simply in inserting the bolt in the receiver and running it back and forth a few times to see that it fits properly and that the locking lugs on the bolt agree with the cam surface on the rear end of the receiver and the cam-locking projections.

Operation 13: Assemble Magazine Floor-plate Catch, Spring, Platform and Floor-plate to Magazine and Trigger Guard.—This consists first in placing the spring over the magazine floor-plate catch; then this member is inserted in the hole in the magazine and trigger guard, and the retaining pin is driven in. The magazine spring is then slipped into the platform and floor-plate, the latter inserted, and the floor-plate locked in position.

Operation 14: Assemble Stock Mortise Band to Receiver and Receiver Assembly to Barrel.—This operation consists in placing the mortise band on the front end of the receiver and screwing the barrel into the receiver; a special fixture is designed for this purpose, the indicating points on the barrel and receiver being made to match up with each other.

Operation 15: Assemble Butt Sling Swivel in Block and Drive in Locking Pin.—This is accomplished in a special bench

fixture provided with a lever for offsetting the ends of the swivel so that it can be inserted in the holes in the block. The retaining pin is then driven in.

Operation 16: Assemble Lower Band and Spin Over End of Swivel Screw.—This consists in inserting the swivel in the slot, inserting the screw, and screwing on the nut. The assembled member is then placed under a rivet spinning machine and the end of the screw spun over.

Operation 17: Press Rear Guard Screw Bushing into Stock.—This is accomplished under a special bench or foot press.

Operation 18: Assemble Miscellaneous Parts to Stock.—In this operation a clearance hole is first drilled for the retaining bolt fulcrum screw; then the butt plate is located on the butt end of the stock, and the two screws are inserted. The butt sling swivel block is then placed in position and the two screws are inserted. The upper and lower band spring catches are then driven into the stock, the upper band nose plate put on and the retaining pin driven in.

Operation 19: Assemble Barrel, etc., to Stock.—This operation consists first in inserting the barrel, receiver and bolt assembly in the grooves in the stock in the proper position,

TABLE XXXIX. ASSEMBLING AND TESTING OPERATIONS ON A MILITARY RIFLE

Oper. No.	Operation	Machine Used	Tool or Fixture	Hourly Product per Man
1	Barrel proof test	.....	Spec. testing fxt.	10*
2	Tin seats on barrel for front and rear sight bases	Bench work	Bench fxt.	80
3	Press on and sweat rear and front sight bases on barrel	Bench work	Solder paste Bench fxt. Burner burner	30
4	Drill and countersink locking screw holes in sight bases	Two-spindle sensitive drill mach.	Spec. fxt.	50
5	Fit and assemble front sight	Bench work	Bench vise, files, etc.	40
6	Fit and assemble rear sight leaf spring, leaf, slide and catch	Bench work	Bench vise, files, etc.	20
7	Assemble sear and trigger	Bench work	.....	100
8	Fit and assemble retaining bolt	Bench work	.....	60
9	Assemble sear and retaining bolt to receiver	Bench work	.....	45
10	Fit and assemble extractor and extractor collar to bolt	Bench work	Bench vise, files, etc.	40
11	Assemble striker, main spring, bolt plug, safety lock and cocking-piece to bolt	Bench work	.....	40
12	Assemble bolt to receiver	Bench work	Bench work, files, etc.	45
13	Assemble magazine floor-plate catch, spring, platform and floor-plate to magazine and trigger guard	Bench work	Bench vise, etc.	30
14	Assemble stock mortise band to receiver and receiver assembly to barrel	Bench work	Spec. assemb. fxt.	20
15	Assemble butt sling swivel in block and drive in locking pin	Bench work	Spec. assemb. fxt.	50
16	Assemble lower band and spin over end of swivel screw	Riveting mach.	.....	45
17	Press rear guard screw bushing into stock	Spec. arbor press	Spec. fxt.	100
18	Assemble miscellaneous parts to stock	Bench work	.....	30
19	Assemble barrel, etc., to stock	Bench work	.....	25
20	Assemble magazine and trigger guard assembly to stock	Bench work	.....	25
21	General inspection for action	Bench work	.....	40
22	Test and align sights	Spec. testing mach.	Spec. cross-hair sighting rod and target	10*
23	Final firing test	Spec. testing mach.	Target Machinery	10*

* Two men.

then turning up the rear sight leaf and inserting the hand guard over it and under the stock mortise band. The lower band is then slipped over the stock and driven over the lower band spring catch, after which the upper band is inserted likewise and driven into position. The cleaning rod is then placed in the cleaning rod clearance hole in the stock and screwed down into the nut, which is a projection of the lower band spring catch.

Operation 20: Assemble Magazine and Trigger Guard Assembly to Stock.—This consists in placing the magazine and trigger guard assembly in the opening in the stock and putting in the rear and front screws.

Operation 21: General Inspection for Action.—This consists in a careful inspection of all the working parts of the rifle to see that they work freely and without obstruction, and that every part has been assembled in its proper position.

Operation 22: Test and Align Sights.—There are several methods in use for testing the alignment of rifle sights. The

TABLE XL. EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT 200 MILITARY RIFLES IN EIGHT HOURS

Name of Equipment	Size or Type	No. of Mchs.	No. of Operators	No. of Non-producers
Cutting-off machines	No. 5	12	1	2
"Stiles" punch press (geared)	No. 5	1	1	2
"Stiles" punch press (flywheel)	No. 5	3	3	6
Board drop-hammer	800-pound	3	3	6
Board drop-hammer	1200-pound	3	3	6
Trimming press	No. 5	11	1	3
Power forging machine	2-inch	1	1	1
Lincoln type milling machine	11 by 36-inch	15	7	10
Lincoln type milling machine	7 1/2 by 32-inch	65	30	10
Hand milling machine	No. 6 Whitney	96	72	10
Profiling machine	No. 13 one-spindle	18	15	4
Profiling machine	No. 14 two-spindle	18	15	4
Spline milling machine	Special	16	5	4
Horizontal splicing machine	Two-head	5	3	4
Vertical bench shaving machine	Pratt & Whitney	9	7	4
Oscillating milling machine	Hendey	1	1	4
Broaching machine	No. 1 Lapointe	1	1	4
Broaching machine	No. 3 Lapointe	2	1	4
Broaching machine (duplex)	No. 3 Lapointe	2	1	4
Plain milling machine	No. 2	1	1	4
Thread milling machine	Internal	1	2	4
Thread milling machine	External	2	2	4
Horizontal radial drilling machine	No. 1 Rockford	1	1	4
Butt welding machine	No. 2-A	2	1	4
Turret lathe	1-inch	13	10	4
Turret lathe	1 1/2-inch	3	6	4
Hand screw machine with thread chasing attachment	3/8-inch	3	2	4
Multi-spindle auto. screw mach.	1 1/4-inch	4	2	4
One-spindle auto. screw mach.	No. 00 B. & S.	1	1	4
One-spindle auto. screw mach.	No. 0 B. & S.	1	1	4
One-spindle forming and cutting-off mach.	No. 00 B. & S.	1	1	4
Screw shaving machine	No. 1	2	2	4
Screw slotting machine	Special	1	1	4
Engine lathe	14-inch	8	6	4
Barrel turning lathe	Multi-tool type	9	2	4
Double-head centering machine	Whitton	1	1	4
Gun barrel drilling machine	Two-spindle	11	3	4
Pistol barrel drilling machine	Two-spindle	3	1	4
Gun barrel reaming machine	Two-spindle	8	3	4
Gun barrel chambering machine	Special	10	8	4
Gun barrel rifling machine	Horizontal	21	5	4
Cylindrical grinding machine	10 by 36-inch	4	3	4
Disk grinder	Grinding wheel stand	1	1	4
Vertical surface grinder	Blanchard	2	2	4
Sensitive drilling machine	One-spindle	2	2	4
Sensitive drilling machine, one with tap. att.	Two-spindle	9	7	4
Sensitive drilling machine	Three-spindle	6	5	4
Sensitive drilling machine	Four-spindle	4	3	4
Sensitive drilling machine	Five-spindle	3	2	4
Sensitive drilling machine	Six-spindle	3	2	4
Vertical drilling machine	One-spindle	1	1	4
Bench bending machine	Special	1	1/2	4
Bench tapping machine	Special	2	1 1/2	4
Polishing lathe	Bench No. 3	20	17	4
Polishing lathe	Stand No. 3	20	17	4
Tumbling barrel	Abbott	1	1/2	4
Sensitive drilling machine	Two-spindle	1	1	4
Engraving machine	I-A Gorton	2	2	4
Riveting machine	Grant	1	1/2	4
Marking machine	Noble & Westbrook	2	2	4
Miscellaneous tools and fixtures	Bench vise	..	14	4
Chronograph and fixtures	Spec. fixt.	..	18	4
Inspecting fixtures and gages	Special	..	..	4
Barrel straightening fixtures	.....	..	6	4
Browning oven	.....	..	1	4
Annealing furnaces	Barrel	3	3	4
Annealing furnaces	.....	3	3	4
Pickling baths	.....	6	6	4
Cyanide pots	.....	2	1	4
Hardening furnaces	.....	4	4	4
Niter baths	.....	5	5	4
Bluing furnaces	"American Gas"	2	1	4

oldest is to hold a rifle in a machine rest and set the sights by actually firing loaded cartridges at a target located about 180 feet from the muzzle of the gun. This method of setting the sights, of course, has the defect that the inspector cannot always be sure that the axis of the barrel and the sights are parallel, because there may be some defects in the ammunition used. The latest and no doubt the most practical method of aligning the sight is shown in Fig. 67. This method of setting the sights makes use of a special sighting tube known as a "star gage," which is made from a bar equal in diameter to the bore of the rifle and drilled through from one end to the other. In one end a small peep sight hole is drilled, and in the other a larger hole, across which are two wires meeting at the center in the axis of the rod. This sighting device is placed in the bore of the barrel, the bolt mechanism being removed, and one operator sights it so that the cross wires coincide with the cross marks on the target which is placed at a distance of 75 feet from the muzzle of the rifle and illuminated. The other operator adjusts the machine rest until the cross wires in the sighting device and the target exactly coincide. The fixture is then clamped, and the front sight aligned with the target. When this is made to coincide with the target, a cold chisel is used to make a cross mark on the sight and sight base. This effectively locates the two mem-

bers and at the same time holds them rigidly. By this method of sighting, it will be seen that the ammunition does not enter into the problem at all.

Operation 23: Final Firing Test.—Ten per cent of all rifles are tested by actual firing, the target being located 600 yards from the muzzle. The rifle is held in a machine rest designed to approximate the conditions it is ordinarily fired under as regards points of support, recoil, etc. At this distance nine out of ten shots must hit within a two-foot circle. The rifle is then given a general inspection and is finally packed ready for shipment.

In addition to the tests previously outlined, a military rifle must also pass through several other tests, viz., an endurance test, dust test, rust test and defective cartridge test. Of course each barrel or rifle does not require to be tested, and generally one rifle out of a consignment decided upon by the government, and which differs in various countries, is tested.

Endurance Test.—The endurance test is made with several rifles, firing 5000 rounds in forty lots of 100 rounds each, and two lots of 500 rounds each. At various stages of the endurance test, the ballistic qualities of the rifle are tested by firing for velocity and accuracy, and the working of the mechanism is tested for rapidity of fire.

Dust Test.—The dust test is not specified by all the governments. The United States Government, however, requires the Springfield rifle to pass this test. It is handled in the following manner: With the breech-block closed, the rifle is subjected to a blast of fine sand for two minutes; first with the magazine empty and again with the magazine filled with cartridges. The surplus sand is removed after each blast by blowing or wiping and by tapping the butt and muzzle of the rifle on the ground. The rifle then must be capable of operating freely as a single loader and as a magazine rifle.

Rust Test.—Most modern military rifles are given what is known as a rust test. The rifle is first thoroughly cleansed, and all oil and grease removed by washing in hot soda water. The muzzle and chamber of the barrel are then corked and the rifle is immersed in a saturated solution of sal-ammoniac and then exposed to a damp atmosphere for forty-eight hours. The accumulated rust must not prevent operation.

Defective Cartridge Test.—In order to test the strength of the extractor, defective cartridges are fired from the rifle. Several cartridges are cut through at the head, others at the

TABLE XLI. EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT 200 MILITARY RIFLE STOCKS AND HAND GUARDS IN EIGHT HOURS

Name of Equipment	Size or Type	No. of Mchs.	No. of Operators	No. of Non-producers
Planing and jointing machine	16-inch	1	1 1/2	4
Four-roll surface planer	24-inch	1	1 1/2	4
Trimming saw	One-head	1	1	4
Equalizing saw	Double-ended	1	1 1/2	4
Band sawing machine	36-inch	1	1 1/2	4
Horizontal boring machine	Two-spindle	1	1 1/2	4
Horizontal boring machine	One-spindle	1	1	4
Horizontal boring machine	Two-spind. opposing	1	1 1/2	4
Gun stock copying lathe	Special	8	3	4
Semi-automatic gun stock lathe	Special	4	3	4
Spotting machine	Spec. horiz.	1	1 1/2	4
Inletting and bedding machine	Six-spindle	5	4	4
Inletting and bedding machine	Five-spindle	2	2	4
Inletting and drilling machine	Four-spind. spec.	1	1 1/2	4
Inletting and drilling machine	Three-spindle	3	2	4
Inletting and bedding machine	Spec. hand guard	1	1	4
Combination vertical profiler and trimming saw	Special	1	1 1/2	4
Vertical shaper	Two-spindle	3	2	4
Grooving machine	Special	1	1 1/2	4
Mortising machine	No. 1 special	1	1 1/2	4
Shaping machine	Special horiz.	1	1	4
Polishing lathe	Special	3	2	4
Gaining machine	No. 1 special	1	1	4
Oil dipping tank	Special	1	2	4
Hand tools, etc.	.....	..	5	4
Inspection fixtures and gages	.....	..	..	4
			Machinery	5

extractor groove, and others are split through their entire length. These are fired, and if the extractor removes them satisfactorily from the chamber, the rifle passes inspection.

EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT AND ASSEMBLE 200 MILITARY RIFLES IN EIGHT HOURS

The problem of equipping a plant to turn out 200 modern military rifles in eight hours is an enormous proposition. In

the first place, to pass inspection a modern military rifle should go together without any hand fitting or filing. Consequently great care must be exercised in the laying out of the various operations, using the same bedding or locating points for holding and gaging the work. Tables XL and XLI give some idea of the equipment necessary. This includes such machines as punch presses, forging machines, drop-hammers, Lincoln type milling machines, hand milling machines, profilers, spline milling machines, drilling machines, etc., and the necessary equipment for turning out the stock and hand guard.

In making a total estimate of the production figures given in the preceding tables covering the operations on the sixty-two parts of a Spanish Mauser military rifle, it has been ascertained that the actual man-hours required to turn out a single rifle is sixteen. This does not include the labor on the bayonet, scabbard, or strap, which would probably increase the man-hours to seventeen or slightly more. For a plant of this size, the actual number of employees, not including the engineering and office force, would be slightly over 400 machine operators; fourteen foremen for manufacturing department; twenty-one sub-foremen; fourteen tool repair men; eleven clerks; twenty-five inspectors and chief inspectors; eight laborers; fifteen to twenty-five toolmakers (for upkeep of tools only). The majority of sub-foremen are producers, as they are over gangs and are working foremen setting up the machines and directing the work of other operators while their own machines are working. The total number of operations on a Spanish Mauser military rifle is in the neighborhood of 757, which includes machining, polishing, heat-treating, assembling, testing, etc.

The stock and hand guard can be turned out in $1\frac{1}{2}$ man-hour, by using the special equipment outlined in Table XLI. In calculating the number of machines required to turn out any particular part, it is necessary to make allowance for breakdowns and for the time required to change over from one job to the next; both of these items vary with the type of machine. For instance, the time required to change over from one job to the next on a sensitive type drilling machine is much less than the time required to change over an automatic screw machine; and a Lincoln miller is likely to be out of order a much greater proportion of the time than a profiling machine. This makes it necessary to handle each case separately, so that the type of machine and other factors can be taken into consideration. To take care of breakdowns, from 10 to 25 per cent is added to all types of machines over and above the calculated number.

* * *

COPPERLESS MACHINERY IN GERMANY

The war has caused a great shortage of copper for other uses than those of martial character in Germany. Electrical firms in that country have been constructing transformers having zinc windings for some time past, and are now engaged in the production of generators and motors with windings made entirely or partly of zinc and commutators of steel.—*Electrical Review and Western Electrician*.

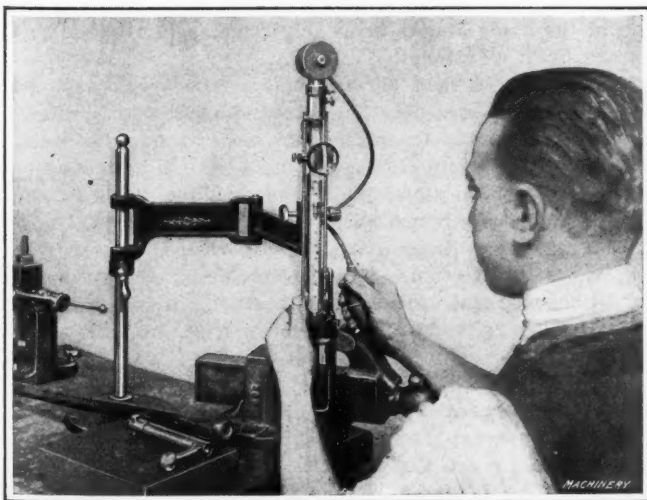


Fig. 1. Testing Hardness of Rear Cam on Receiver

TESTING HARDNESS OF RIFLE PARTS

BY A. F. PHORE*

In order that a military rifle may stand up to the rough usage incident to service in war, it is necessary not only that it be strongly constructed, but also that the various parts be made from suitable materials of the correct hardness and elasticity. As the working members of the rifle are subject to considerable wear, it has been found necessary to heat-treat such parts as the receiver, bolt, trigger, sear, etc. It is doubtful if the hardness of these parts has ever been standardized. It does not require a very careful investigation to see that the working members of a military rifle are not subjected to the same conditions of service, and consequently should be of varying hardness and tensile strength. The rifle barrel is a good case in point. In the rifle barrel the stress caused by the explosion of the powder in the cartridge is greatest at the breech end, which calls for an enlargement of the barrel at this point.

Hardness of the Rifle Barrel

A satisfactory rifle barrel must meet two requirements: first, it must be capable of withstanding the enormous pressure exerted by the explosion of the powder in the chamber, which in the Springfield rifle is about 44,000 pounds per square inch; second, it must be capable of withstanding the erosive effect of the gases formed when the powder in the cartridge case is exploded. Erosion is caused by the heated explosive gases moving with high velocity under great pressure. These gases attack the walls of the bore, which are probably softened by the heat, and cut irregular channels in the metal, destroying the surface of the bore and rifling. Erosion is greatest at the seat of the bullet immediately in front of the cartridge case and extends forward into the barrel for several inches. Beyond this, the walls of the bore are practically unaffected. It is therefore evident that the hardness of the barrel is not as important a consideration as its ability to resist the pressure and erosive effect of the gases.

Many experiments have demonstrated the fact that alloy steels which can be employed satisfactorily to resist the breech pressure do not prolong the life of the rifle barrel because they are not capable of resisting erosion. It has also been demonstrated that plain carbon steel of the correct physical properties makes a much more satisfactory barrel than nickel steel or other alloys. A steel which has come into prominence for use in rifle barrels is known as "smokeless barrel steel." The various ingredients in this steel are: 0.40 to 0.50 per cent carbon; 1.15 to 1.30 per cent manganese; 0.18 to 0.25 per cent silicon; 0.08 per cent (maximum) phosphorus; 0.06 per cent (maximum) sulphur. This steel has a tensile strength of from 100,000 to 120,000 pounds per square inch, and an elastic limit of 60,000 to 75,000 pounds per square inch; reduction of area, 40 to 55 per cent; elongation in two inches, 20 to 30 per cent. The hardness of the barrel is not fixed by the hardness of the bullet jacket; the jacket has little or no effect in wearing

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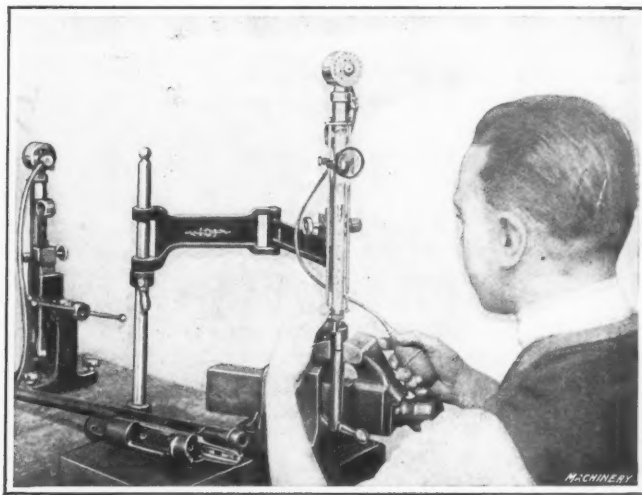


Fig. 2. Testing Hardness of Front End of Bolt

out the barrel. It has been demonstrated that a soft steel jacket wears the barrel less than a cupro-nickel jacket. The reason for this is that nickel, being softer than steel, causes fouling, which results in more wear than is caused by steel jackets with which fouling is eliminated. Therefore the two most important factors influencing the durability of a barrel are pressure and erosion. The hardness of rifle barrels varies between 40 and 50 under the scleroscope.

Hardness of the Firing Pin

The firing pin must be capable of indenting the primer but does not need the characteristics of a cutting tool. The primer, which is made from a copper alloy, strikes between 15 and 20 on the scleroscope. While the firing pin does not perform the function of a cutting tool, it nevertheless should be at least three times as hard as the primer, and for this reason should not strike less than 60. Increasing the hardness serves to strengthen the pin, so it is generally made to strike about 85. This increased hardness also gives the pin better wearing quality which is desirable because of the presence of grit and dust. Thus a hardness of 85 to 90 may be used, but this is not absolutely necessary.

Hardness of the Receiver Cams

The hardness of the cams in the receiver (see Fig. 1) should have a minimum of 60 to resist battering under ordinary hand pressure. These points on the receiver are also subject to wear due to the presence of grit when the rifle is in use on the battlefield. A receiver is generally made from a steel that can be heat-treated so that the exterior surface is hard and the core soft.

Hardness of Extractor

The extractor, which is used in extracting the cartridge from the chamber of the barrel, has a flexible or spring body which may have a minimum hardness of 55 to 60. The hook engages with a brass cartridge case which is 30 to 35 hard, but as no cutting is done, the well recognized hardness relation of three to one is not necessary. However, when a cartridge case sticks and the pressure on the brass is close to the cutting pressure, a hardness high enough to meet this condition prolongs the life of the extractor hook. The minimum hardness advisable is 75 and the maximum 85. The maximum requirement of 85 is due to the fact that the steel must be very tough, and toughness can only be obtained by drawing the temper down at least ten points. The higher hardness can only be obtained uniformly by the use of an 0.90 to 1.00 per cent carbon steel. The lowest carbon content allowable is 0.50 per cent.

Hardness of Gun Springs

Many tests have demonstrated that the minimum hardness for gun springs is 55 and the maximum 65 to 70. Below 55 the steel weakens rapidly, and the elasticity is too low to permit the desired flexure. The flexure of any steel spring is greatest at 85 hard, but only in alloy steels is there a sufficient factor of safety available at this hardness. Carbon steel springs take considerable permanent set before fracture when 70 hard, and are thus tough enough to resist violent shocks even though stressed very close to the elastic limit during service.

Hardness of Sliding Parts

Sliding parts which are exposed to continuous hand pressure need not be harder than other heat-treated steel having, say, a minimum hardness of 30 to 35. The principal advantage of having the higher hardness is in resisting wear due to grit. Even without heat-treatment, sliding parts exposed to continuous hand pressure usually outwear the bore. Parts exposed to violent shock or impact such as the bolt (see Fig. 2) should have a minimum hardness of 60 in order to prevent battering and upsetting.

Hardness of Casehardened Parts

In small casehardened parts which are not subjected to violent impact, the hardness may be as high as can be obtained by quenching without drawing. When these parts are sub-

jected to considerable torsional stress, as is the case on the bolt and receiver, the casehardened surface should show a hardness of at least 85 when the temper is not drawn. This hardness is desirable principally because of the depth of case necessary to give such a hardness reading on the scleroscope, and upon which the resistance to battering would depend. As an example, mild steel, 21 hard, may be casehardened in cyanide to resist the file. When tested with the scleroscope it may show no more than 25 hard. The reason for this is that the hardened case is so thin that, though it resists the file, it cannot resist the battering impact of the scleroscope drop-hammer. It thus requires a hardness depth of at least 0.01 inch to give a reading of about 85 hard on the scleroscope. If the case is thinner than this and the core is perhaps not more than 25 hard, there will be a lower reading shown under the scleroscope because of the lack of support for the drop-hammer's impact. Hence in this instance, where only a slight depth of hardening is required, the scleroscope becomes a faithful detector of the depth of the hardened case.

* * *

OXY-ACETYLENE WELDING OF ALUMINUM

BY FOREMAN

The article by S. W. Miller which appeared on page 461 of the February number of MACHINERY shows that modern methods of autogenous welding have been developed to provide for welding aluminum alloys, a class of work which was formerly considered impossible. Personally, I think it would have been more appropriate if Mr. Miller had entitled his article "Oxy-Acetylene Welding of Aluminum Alloys," as the title used is rather misleading. In the article referred to it is stated: "Aluminum is seldom used in its pure condition, as it is too soft." While it is conceded that aluminum is unsuitable for many classes of work owing to its softness, this limitation applies only to the pure metal. At the present time there are undoubtedly a great many products made of pure aluminum, and these are extensively used in many lines of manufacturing. Pure aluminum is sold in the form of sheets, bars, strips, rods, tubes, etc.; in fact, the writer is acquainted with one manufacturer of aluminum who produces no less than 700 different drawn and extruded sections made from pure aluminum.

In his article Mr. Miller also makes the following statements: "The author doubts the advisability or necessity of using flux"; and, "It is frequently stated that it is impossible to make a sound weld in aluminum without a flux which will destroy the oxide." I agree most heartily with the latter statement, as it may be safely stated that a weld made in aluminum without the use of flux is not likely to result in the production of homogeneous metal. Consequently, it is advisable to use a suitable flux which will cause the oxide to melt or break down at the same temperature as the aluminum. This is obvious when it is explained that the melting point of metallic aluminum is 657 degrees C. and that of aluminum oxide is nearly 3000 degrees C. Therefore it is evident that welds made by mechanical puddling are not likely to result in the development of a homogeneous metal structure, as a portion of the oxide almost invariably remains in the weld and detracts from its strength.

In cases where such parts as automobile crank-cases and transmission cases are to be welded, I agree that sufficient strength can be obtained without the use of a flux, the reason being that these parts are usually made of an aluminum alloy and not from pure aluminum. When making welds in pure aluminum where a homogeneous structure of the metal is required, difficulty will sometimes be experienced, especially in the case of thin sections. Another troublesome case is where a weld must be made in a vertical position without the use of a flux. This is practically impossible; but the same welds can be readily made by using a suitable flux.

* * *

The proportions of a countersunk bolt head should be such that the diameter at the upper end of the conical head is equal to twice the diameter of the bolt. The length of the conical head should be five-eighths of the diameter of the bolt.

ELECTRIC WELDING FIXTURE

An electric welding operation of more than ordinary interest is carried on at the North East Electric Co.'s plant in Roches-

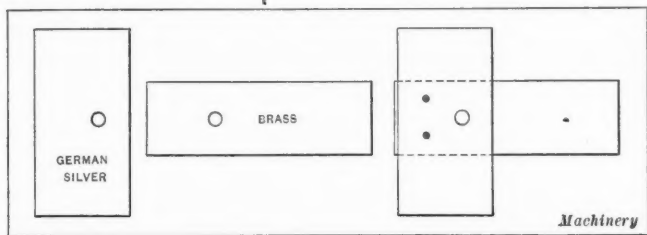


Fig. 1. Parts to be welded

ter, N. Y., in making the "North-East" electric starting and lighting outfit for automobiles. The operation consists of spot-welding a German silver relay contact to its brass holder. Fig. 1 shows the sheet metal parts separately and as they appear after making the two spot-welds necessary to join them. The parts must be located squarely before welding, and the holes in the two pieces must be in line. The fixture for holding the work was designed to meet these conditions, and as

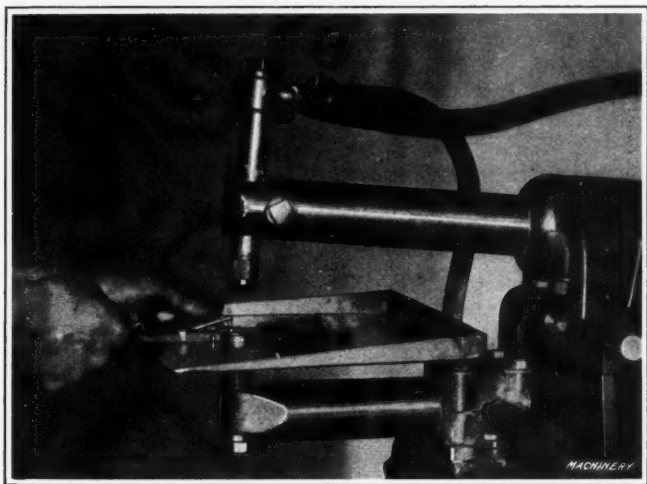


Fig. 2. Welding Operation

it is not practical to make two spot-welds simultaneously with one pair of electrodes, provision had to be made for moving the work to make the two welds separately.

Referring to Fig. 3, it may be seen that the fixture is of the swiveling type; the first and second positions occupied in making the welds are shown in full and dotted lines, respectively. The brass brush-holder is first dropped into a shallow slot in

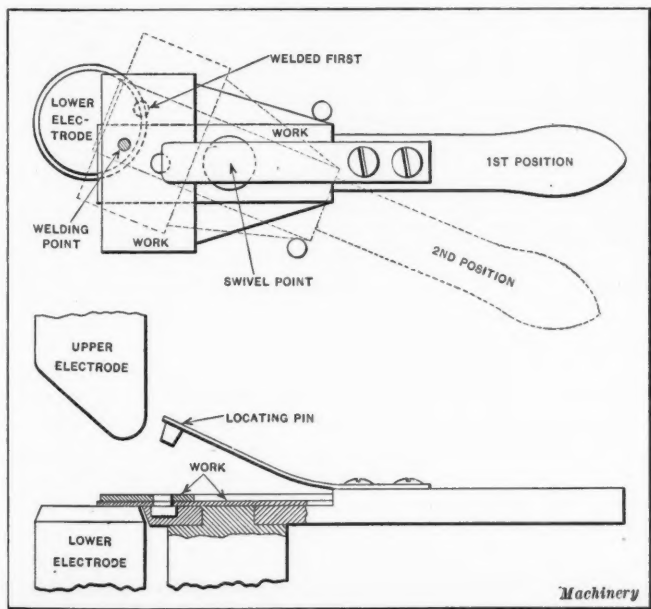


Fig. 3. Details of Welding Fixture

the fixture, the rear end resting against a shoulder. The German silver part is next laid over the brass part and at right angles to it. The operator now presses down the spring locating pin that centralizes the parts and lines up the two holes. As soon as the finger pressure on the locating pin is released, it springs up out of the way until needed for the next piece. The foot-lever of the welding machine is depressed to make the first weld. The fixture is then swiveled to bring the second welding point into position under the electrodes, and the second weld is made, completing the job very rapidly. C. L. L.

* * *

SAVING STOCK WITH STEEL TUBING

The Meisel Press Mfg. Co. of Boston, Mass., had several thousand special steel spinning rings to manufacture under contract. Fig. 1 shows one of these rings full size and gives the important dimensions. Several methods could have been

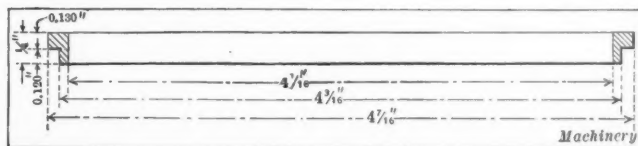


Fig. 1. Spinning Ring made from Shelby Tubing

used in making these rings, but it was decided to make them from Shelby steel tubing, doing the turning in an engine lathe with a Conradson turret attachment. It will be appreciated that a big saving in stock was secured by this method of manufacture. The extreme diameter of the rings was $4 \frac{7}{16}$ inches, and the inside was $4 \frac{1}{16}$ inches. The extreme thickness of the ring was $\frac{1}{4}$ inch. It was required that these rings be turned to within 0.001 inch of the correct diameter. The tubing was held in the lathe chuck and supported by a steadyrest near the extreme end, as shown in Fig. 2. With the aid of the turret attachment, the outside diameter was turned to a diameter of $4 \frac{7}{16}$ inches, over a length of about

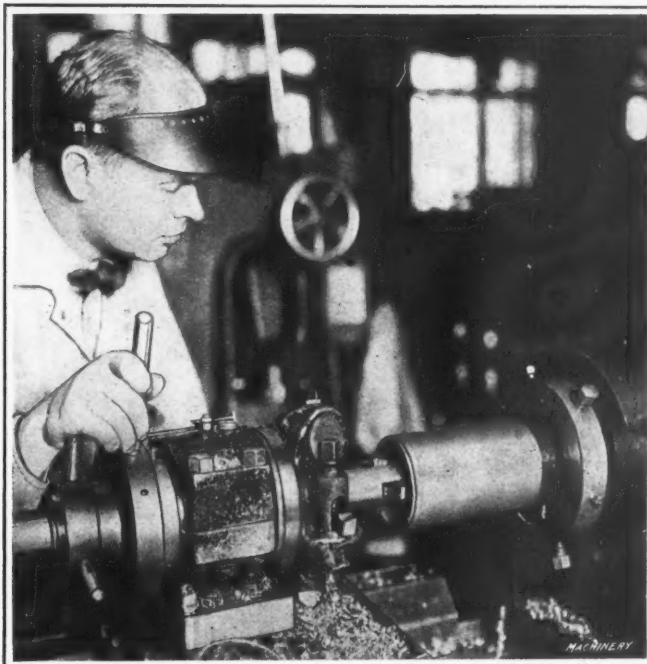


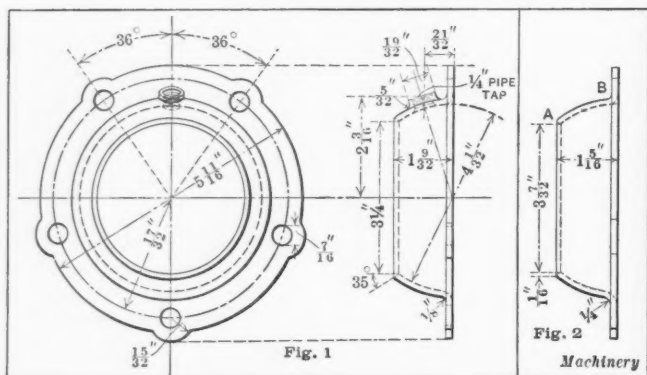
Fig. 2. Using the Conradson Turret to make Spinning Rings from Tubing

10 inches. The inside was next bored to $4 \frac{1}{16}$ inches diameter for a similar distance. Then the shoulder was formed on the end of the bar and one of the rings cut off. These last two operations were continued until all of the turned section had been worked up, at which time the steadyrest was moved along and a new length of tubing worked upon.

No heavy cuts were necessary, and the operation resolved itself into one of taking light cuts with practically no waste of stock. The production was 150 pieces per day of ten hours. Shelby steel tubing comes in so many sizes that it is possible to secure the required size for almost any ring job. C. L. L.

PRESS-WORK ON A UNIVERSAL JOINT COVER

BY ERNEST A. WALTERS*



Figs. 1 and 2. Universal Ball Cover and Condition of Work after finishing First Operation

The universal joint cover illustrated in Fig. 1 is one of two parts of a gasoline motor transmission. This part is made of 5/32-inch hot-rolled steel and is finished under the punch press in three operations. It must be of uniform strength at all points, and for this reason great care must be exercised in performing the press-work in order to avoid stretching the metal in a way that would lead to the rejection of the work when it reached the inspection department. As previously stated, the stamping is made in three press operations which have been worked out in a way which affords a very satisfactory rate of production.

Under ordinary conditions, it would take about nine operations to complete this stamping, these operations being about as follows: 1. Stamp out the round blank and perform the first drawing operation. 2. Re-draw to the proper shape and reduce the 1/4-inch radius under the flange to 1/8 inch. 3. Trim the work to the required diameter. 4. Perforate the bottom. 5. Perforate the hole in the wall where the boss is to be drawn. 6. Draw the boss. 7. Trim the bottom of the work and turn the edge to the required 35-degree angle, an engine lathe being employed for this purpose. 8. Perforate five 7/16-inch holes in the flange. 9. Re-strike the work in a press to flatten the flange and eliminate distortion caused by drawing the boss.

When the method of procedure outlined in the preceding paragraph is compared with the work of the dies which en-

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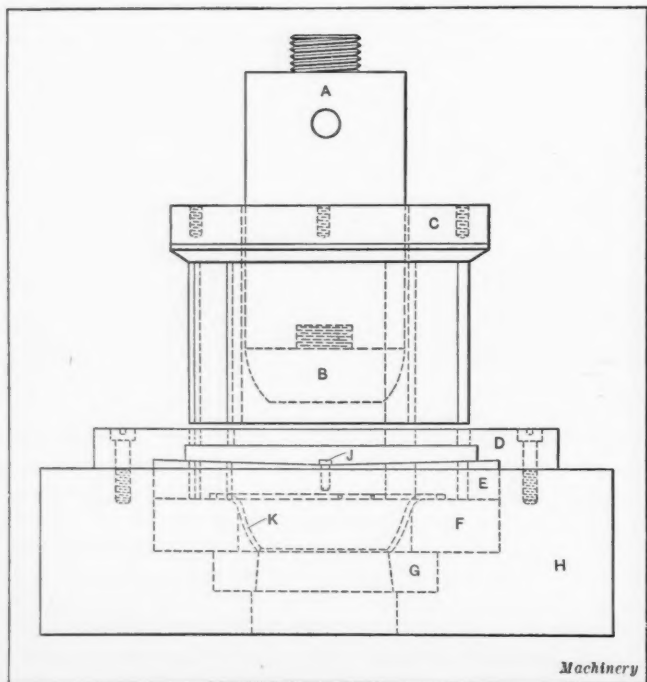


Fig. 3. Punch and Die used to bring Work to Form shown in Fig. 2

able the entire piece to be finished in three operations, the saving in the cost of production will be readily appreciated. This is a good example of how it pays to expend the necessary amount of money in developing the proper method of doing work at the start, and in this connection it may be mentioned that a set of templets should be made for the punches and dies when they are new, so that the proper form of the tools is not lost as the result of wear. The occasional use of the templets enables both the punches and dies to be re-ground when necessary to preserve the required shape. For instance, it is important for the radii of curvature on both the punch and die used for performing the first operation on this job, to be held quite close to the original dimensions in order to obtain uniform stampings. To allow these radii to change from their original lengths through wear would naturally result in changing the dimensions of the stampings as well as their extreme diameters.

Fig. 3 shows the punch and die used for performing the first operation. Referring to this illustration, it will be seen that A is the drawing punch which is made of machine steel and provided with a high-speed steel point B which can be readily replaced when necessary. The blanking punch is shown at C and this punch also acts as a blank-holder while the drawing operation is in progress. The stripper provided to strip the steel from the blanking punch is shown at D. It will be evident that E is the blanking die and F the drawing die, while the perforating die employed to remove the bottom of the stamping is shown at G. These three dies are of the ring type; the drawing die is made of high-speed steel, while the blanking die E and perforating die G are made of carbon tool steel. The three ring dies described in the foregoing are held in the cast-iron die-holder H, as shown.

A brief consideration will make it evident that the height of the drawing die must be maintained constant in order to insure the proper depth of the stamping. The gage pin J is provided to space the blanks properly. The way in which the bottom of the stamping is perforated is somewhat unusual. For this purpose, the punch must be set, so that it does not touch

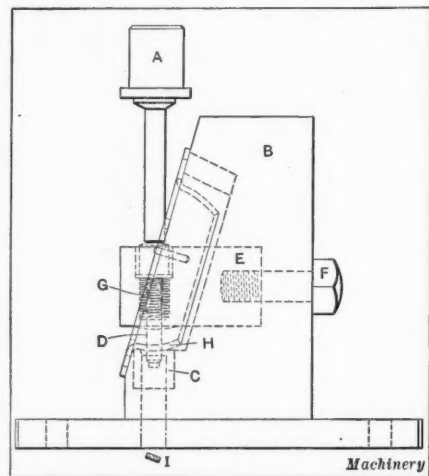


Fig. 4. Punch and Die for piercing 5/16-inch Hole and drawing up a Boss around it

the sharp edges of the perforating die G, and at the same time close enough so that it will force out the bottom of the stamping. To avoid damage to the die, care must be exercised in setting up the tools, and after they are set up with all bolts and nuts properly tightened, there is seldom any need to make further adjustment. Literally speaking, the punch and die does not cut out the bottom of the stamping K, but rather crushes it out part way and then the bottom breaks away. The edge is clean and even all around and it is inclined at an angle of about 20 degrees which makes it easier to finish the third operation, i. e., finishing the edge to the required angle of 35 degrees.

The second operation combines two ordinary operations, viz., perforating a 5/16-inch hole and drawing out the boss at the same time. The thickness of the steel makes it possible for the 5/16-inch punch to go through without drawing the work to any appreciable extent, and when the shoulder on this punch comes into contact with the work, it draws the steel down into the die to form the required boss. Referring to Fig. 4, which shows the punch and die used for performing this operation, the punch is shown at A and the die or bushing holder at B. It will be evident that the die-holder B serves the additional purpose of a gage which locates the

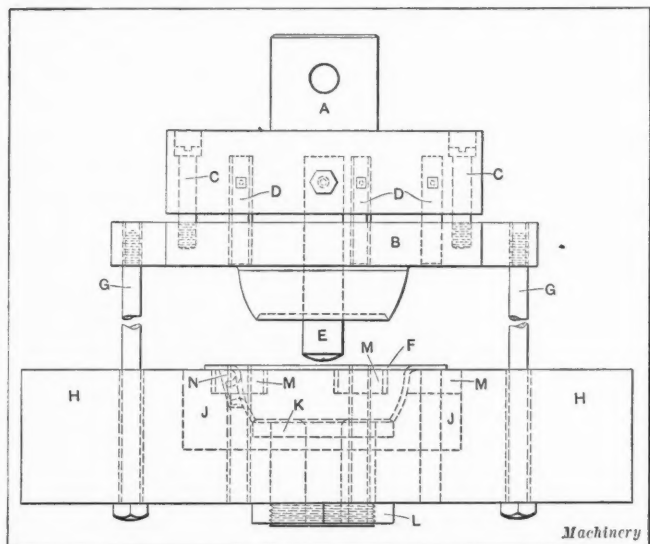


Fig. 5. Punch and Die for piercing Holes in Flange, beveling Bottom Edge of Shell and truing up Work

work in the desired position, and that the perforating and drawing die *C* is mounted in the holder *B*. The perforating and drawing punch *D* is seated in and guided by the extension block *E*, which, it will be seen, is held in place in the holder *B* by means of the cap-screw *F*. The spring *G* is employed to draw the punch back when it has reached the end of its stroke. It will, of course, be evident that the stamping is shown at *H*, and *I* illustrates the slug of metal which has been perforated from the wall of the stamping previous to drawing the boss.

The third operation provides for reducing the $\frac{1}{4}$ -inch radius at the flange to $\frac{1}{8}$ inch, and also flattening the flange to correct for any distortion which may take place in perforating the shell and drawing up the boss. This operation also perforates five $\frac{7}{16}$ -inch holes in the flange and bevels off the bottom of the stamping—which was left rough from the perforating operation—to the required angle of 35 degrees. Referring to Fig. 5, it will be seen that *A* is the punch which has the flattening stripper plate *B* attached to it by means of the screws *C*. The punches for perforating the five $\frac{7}{16}$ -inch holes in the flange are shown at *D*, and the punch is provided with a central guide pin *E* to preserve the required alignment. The stripper plate *B* has a motion of $\frac{1}{4}$ inch to provide for stripping the finished stamping *F* from the perforating punches *D*, the stripper being actuated by the stripper rods *G* which are properly adjusted in relation to the die-holder *H*. This die-holder is made of cast iron and supports the die *J* which is provided with a central plug or punch *K* that forms the 35-degree beveled edge at the bottom of the stamping. The bevel punch *K* is held in place by means of the nut *L* which engages the bottom of the die-block. The perforating dies *M* are dovetailed into the die *J* and can be easily replaced when necessary. It will be seen that clearance for the boss on the stamping is provided in the die at *N*, and this space also acts as a locating point in placing the stampings in the die.

* * *

The manufacture of the so-called lead pencils is carried on principally with machinery made by woodworking machinery builders that specialize in high-grade equipment. A lead pencil plant includes woodworking machinery, conveying machinery, gluing machines, hydraulic presses, and some special equipment. The cedar wood is worked up into strips about seven inches long and is then grooved and made ready for the "leads." The "leads" are made of a mixture of graphite and clay, the proportions being fixed by the required grade of pencil. The mixture is forced through dies in a plastic state by extrusion presses of the hydraulic type, and the extruded rods are cut into lengths and baked. It is true in lead pencil manufacture the same as in other lines, that there is little machinery that might be said to be machinery exclusively for the purpose.

RECTANGULAR PRESSURE VESSELS*

One of the problems that usually gives the machine designer trouble is the calculation of the proper plate thickness of vessels that are rectangular or square, instead of cylindrical in shape, and of the pressure that can safely be allowed in such a square vessel of a given thickness of material. In many types of water-tube boilers the square form is used for several details, such as headers, water boxes and mud drums, and not much trouble is encountered in the way of structural weakness, due to the presence of flat surfaces, because their cross-sectional dimensions are usually not large in comparison with the wall thickness.

With pressures higher than the usual, which are sometimes used for certain processes of manufacture, such as from 300 to 500 pounds per square inch, it becomes desirable to investigate the probable resultant stresses in the square headers and boxes due to internal pressure, so that some idea can be gained as to their safety, especially when they are subjected to the temperature of superheated steam. In the case, for instance, of a superheater header the temperature is a factor to be considered. Take the temperature of steam of 300 pounds gage pressure with a superheat of 100 degrees F. At this temperature, steel is blue hot, a condition in which it requires only about two-thirds of the effort to bend it that it takes when at normal temperature. It is also a widely known fact that a piece of steel which is strained by changing its form at a blue heat acquires an excessive brittleness.

From these facts it appears highly desirable that no deformations of the walls of a vessel take place while at a blue heat, or at least, that whatever change of form takes place due to working pressures be limited to a minimum, and consequently that the thickness of the walls be such as to afford a liberal factor of safety against elastic deflections.

The tendency of a square vessel, a cross-section of which is shown in Fig. 1, is to become round when subjected to internal pressure or in other words, such parts of the circumference as are flat tend to become curved, and the corners to straighten out, as shown in dotted lines. Referring to Figs. 1 and 2, two different sources of stress are readily recognizable, namely: the direct stress due to the tendency to separate as shown in Fig. 2, and the indirect stress, which is produced by the tendency of the vessel to assume a cylindrical form. The direct stress is easily calculated by means of the usual formulas for cylinders. In the case of the small dimensioned vessels with the comparatively thick walls under discussion it is well to use Lamé's formula for thick-walled cylinders in preference to the formula usually employed for boiler shells. The total tangential stress in the material of any cylinder is not evenly distributed throughout the thickness *t*

* Abstract from an article by H. J. Vander Eb, in "The Locomotive," published by the Hartford Steam Boiler Inspection & Insurance Co., April, 1915.

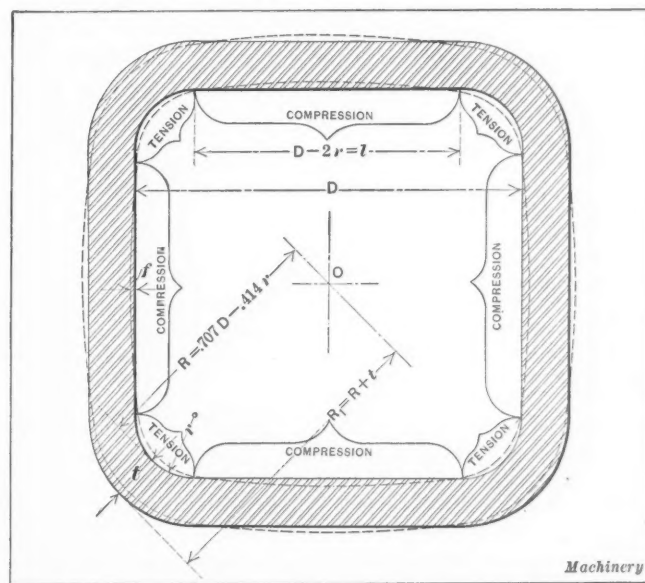


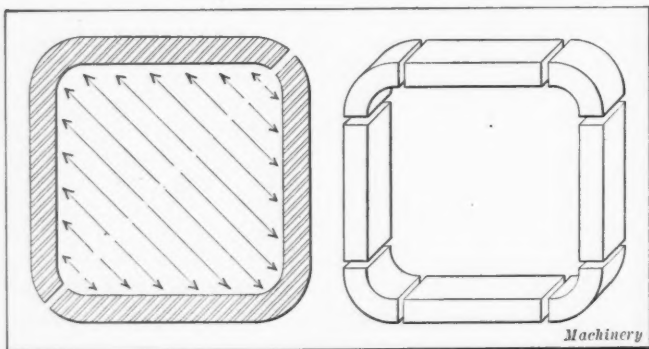
Fig. 1. Notation used in Formulas

of the material, but gradually diminishes from the inner skin of the plate toward the outer skin so that the maximum stress occurs in the inner skin of the metal.

Accordingly, let S represent direct stress in the inner skin of the material, and P , the internal pressure; then, referring to the notations in Fig. 1:

$$S = P \frac{(R_1^2 + R^2)}{(R_1^2 - R^2)} \quad (1)$$

The stresses due to the tendency of the square vessel to become cylindrical are not so easily calculated. Considering what takes place when the internal pressure P is exerted on the walls of the vessel, we observe, as is shown in dotted lines in Fig. 1, that the flat portions bend outward, acquiring a deflection f , while the curved corners tend to straighten, or in other words, acquire a deflection which is in an opposite direction to the deflection f with regard to the center O of the cross-section. If we regard the curved corners as short curved beams, and consider a length of vessel of one inch, we can distinguish two groups of four beams, namely, four straight ones and four curved ones, the straight beams being the sides of the structure. When a simple beam is subjected to a uniformly distributed load, the fibers on the load side



Figs. 2 and 3. Diagrammatic Views showing Stress Distribution

of the neutral axis are compressed or shortened, and those on the other side stretched.

Because of the fact that the four side and corner beams form one continuous structure, but bend in opposite directions from each other, it follows that for elastic deflections the shortening of the inner fibers of one set of beams is equalized by a corresponding elongation in the inner fibers of the other set of beams, or expressed differently: speaking with regard to the total inner surface of a square vessel, it is an obvious law that the sum of all elongation equals the sum of all contraction in that surface, so long as the elastic limit of the material of the vessel is not exceeded by the attendant fiber stresses. Hence if we can calculate the shortening of the inner fibers of one straight beam of the given length $D - 2r$, due to a given pressure load, we may take this result as being equal to the elongation of the inner fibers of one curved beam of the length $\frac{1}{2}\pi r$. It is not the purpose of this article to attempt a complete mathematical analysis of the true stresses as they exist in the different parts of the square structure under discussion, which is extremely complicated, but rather to give a formula for making a safe approximation of the probable maximum stresses.

In the following formula, let:

S_1 = total unit fiber stress in the metal of the inner skin of the curved beam;

P = internal pressure.

The other symbols used in the formula are indicated in Fig. 1.

$$S_1 = P \left(\frac{R_1^2 + R^2}{R_1^2 - R^2} + \frac{P}{5.02 t^2 r} \right) \quad (2)$$

The theory of this discussion, like all theories where the flexure of beams is involved, becomes void as soon as the stresses resulting from the pressure load exceed the elastic limit of the material. It is therefore necessary in all cases to figure the probable maximum stresses in the straight beam first, in order to see whether this is still within the elastic

limit, and also to compare this stress later with the stress found for the curved beam from Formula (2). The maximum unit stress in the straight beam is:

$$S_2 = P \left(\frac{3 P^2}{4 t^2} + \frac{D}{2 t} \right) \quad (3)$$

The allowable pressure on the vessel should then be based on the weakest part, whichever of the beams is found stressed the highest.

With these formulas, the all important radius of the corner fillet is duly taken into account. From the theory of curved beams this is very essential, since in this form of beam, when of rectangular cross-section, the location of the neutral surface does not coincide with the center of gravity of the section as it does in straight beams, but its distance from the

concave side of the beam is proportional to $\frac{t}{r}$. For $\frac{t}{r} = 0$, which is radius = infinity, or a straight beam, the distance of

the neutral surface from the outer fibers is $\frac{t}{2}$. For a curved beam of a microscopically small radius, which is a sharp corner, the neutral surface and the concave outer surface coincide, which makes the stresses in the concave side infinitely large. Between these limits the following values for the distance of the neutral surface to the concave side of curved beams obtain:

$\frac{t}{r}$	Sharp corner	10	5	1	$\frac{1}{2}$	$\frac{1}{10}$	Straight beam
Distance	0	0.317 t	0.358 t	0.443 t	0.466 t	0.492 t	$\frac{1}{2} t$

The fiber stresses in the metal of the concave side of the beams vary inversely as these distances. This shows clearly the importance of having an ample fillet radius at the corners of rectangular vessels.

Example:—A square header has a side dimension of $7\frac{1}{4}$ inches, an internal fillet radius of 1 inch and a thickness of $\frac{5}{8}$ inch. What is the maximum fiber stress at 300 pounds gage pressure? Referring to Fig. 1, the following values appear:

$$D = 6 \text{ in.}; r = 1 \text{ in.}; l = 4 \text{ in.}; t = 0.625 \text{ in.}$$

$$R = 0.707 \times 6 - 0.414 \times 1 = 3.828 \text{ in.}$$

$$R_1 = 3.828 + 0.625 = 4.453 \text{ in.}$$

Then from Formula (3), maximum fiber stress in straight beam:

$$S_2 = 300 \left(\frac{3 \times 4^2}{4 \times 0.625^2} + \frac{6}{2 \times 0.625} \right)$$

$$= 300 (30.7 + 4.8) = 10,650 \text{ pounds per square inch.}$$

This is well within the elastic limit of the material.

From Formula (2), maximum fiber stress in curved beam:

$$S_1 = 300 \left(\frac{4.453^2 + 3.828^2}{4.453^2 - 3.828^2} + \frac{64}{5.02 \times 0.39 \times 1} \right)$$

$$= 300 (6.65 + 32.67) = 11,800 \text{ pounds per square inch.}$$

With material of an ultimate tensile strength of 60,000 pounds per square inch, this header would have a factor of safety of over 5.

* * *

SHAFTS FOR TORSIONAL STIFFNESS—CORRECTION

The statement in the next to last paragraph in the article "Shafts for Torsional Stiffness," on page 794, May number, should read as follows: "For shafts of medium carbon or machine steel, divide the figures by 0.98; for bronze, divide by 0.81; for phosphor-bronze, divide by 0.83; for maple, divide by 0.526; for hickory, divide by 0.513. The errors in this paragraph as it appeared were the use of the term 'multiply' instead of 'divide.'"

* * *

The receipts from the national forests by the U. S. Treasury during the fiscal year ended June 30, 1915, amounted to nearly \$2,500,000—an increase of more than \$40,000 over the receipts during the previous year. The timber sales amounted to \$1,164,000 and the receipts from the water power to about \$90,000.

THE INSPECTION DEPARTMENT*

ITS RELATION TO THE MANAGEMENT OF A MANUFACTURING ORGANIZATION

In any manufacturing company, consideration of the inspection department should begin with a study of the relation of that department to the management of the company and to the various departments of the organization. These relations must be positively fixed and thoroughly understood. In many cases, the inspection department is not rendering the service of which it is capable nor operating at maximum efficiency, on account of lack of cooperation between it and the other departments. It is, of course, the primary function of the inspection department to inspect and pass upon the material submitted to it, approving that which meets the requirements laid down and rejecting that which fails to come up to the adopted standard. At the same time, this department is in a position to render valuable assistance to the sales and purchasing departments as well as to the engineering and production departments, if the spirit of cooperation exists throughout the whole organization.

To Whom should the Inspection Department be Responsible?

In the majority of manufacturing corporations, the inspection department is under the authority of the factory manager or superintendent. In other words, that branch of the organization which builds the apparatus decides whether that apparatus is properly built. It is unnecessary to point out the inherent weakness of this arrangement. The judgment of the inspector may continually be biased by the fact that he is a part of the factory organization and is responsible to the factory management. It is therefore evident that the highest standards of quality and workmanship hardly can be maintained continuously if the members of the inspection department are in any degree subject to the control of a factory superintendent or any other executive who is directly responsible for the factory production and has no connection with the engineering or sales organizations. This statement should not be understood as expressing a doubt in regard to the loyalty or honesty of purpose of any factory official. We must recognize the fact, however, that defects, due to drawings or specifications, are often disregarded by inspectors if they know that no criticism can be attached to them by their superiors on account of the latter's approval of the apparatus, especially when a rejection would prevent meeting a promised date of delivery.

In a smaller number of shops, the inspection department is under the control of the chief engineer. With this arrangement, the judgment of the inspector is likely to be biased by the fact that any defects in the finished product, due to improper specification of materials or any failure of the apparatus to function properly, might be considered as reflecting on the abilities of the engineering department. The inspector will often hesitate to reject a device if he thinks that the objectionable feature may be attributable to his superior officer, as it would imply a difference of opinion that might reflect discredit on the inspector's judgment. Moreover, there is often a tendency among young and subordinate engineers to refuse to recognize slight defects in a design for which they are personally responsible, and to severely criticize an inspector who points out what he considers a defect in such apparatus. Therefore, it will be seen that in most cases the executive head of the inspection department should be as free from control of the engineering department as from the manufacturing department.

The only logical plan of organization is that in which the head of the inspection department, whatever may be his title, is responsible directly to the general manager of the company or the chief executive in control of the factory output. He should report to the same officer as the works manager or the chief engineer. At the same time, he must be in full sympathy with all other departments. He must command the respect of the other department heads and be ready to cooperate with them to further the interests of his company.

* Abstract of a paper read by Fred B. Corey, of Pittsburg, Pa., before Section D of the American Association for the Advancement of Science at the Philadelphia meeting, December 30-31, 1914.

The executive head should exercise a most thorough control over all the activities of the department. To that end, there should be no recognized paths of communication between this department and the heads of the other departments, except through his office. The strict enforcement of this rule is essential to the efficient working of the department and to the avoidance of misunderstandings and duplication of effort. This requirement, if rightly understood, will not be interpreted as limiting the useful activity of any member of the department, but will be recognized as a necessary feature in the conduct of inter-department business.

The Duties of the Chief Inspector

The executive head of the inspection department should be thoroughly familiar with general engineering practice and standards. He should be well informed on all shop methods, including foundry and machine shop practice, and be thoroughly versed in the use of testing machines and gages. He should, if possible, be conversant with chemical laboratory methods and apparatus, so as to be able to direct intelligently that part of his organization. Moreover, he should be familiar with the uses of the factory product and the conditions under which it is to operate after it has passed beyond the control of the factory. He must have absolute control of every inspector in the plant and be held responsible for the quality of material and workmanship of all that the plant produces.

In the majority of manufacturing corporations all dealings with the customers are conducted by the sales department exclusively, which is the logical arrangement. For this reason, complaints on the part of the customer are made directly to the sales department and usually reach the shop through a more or less tortuous channel. There is sometimes a tendency on the part of the sales department to assume that all of these complaints are justified, to criticize the shop for turning out an unsatisfactory product, and especially to blame the inspection department for failure to prevent the issuance of the material in question.

In justice to all concerned, including the sales department, all such complaints should be referred to the executive head of the inspection department for a personal investigation and report, and action on the part of the sales department, except so far as it relates to the replacement of material urgently needed, should be deferred until the report is in hand. This report may entirely change the attitude of the customer with relation to the alleged defective material, as it may clearly show that its failure to meet his expectations was due to no fault of the manufacturer or of the apparatus involved. The trouble may have been due to injury in shipment, rough handling after receipt, failure to install or to apply it properly, lack of proper maintenance on the part of the customer or his employees, or to a misconception of the capacity or function of the apparatus itself. Any errors on the part of the factory or inspection department must be freely acknowledged and any steps to prevent their recurrence should be fully explained. An unbiased report, based on all the available facts, rendered by the head of the inspection department to the head of the sales department, may be invaluable to the salesman in his negotiations with the customer.

Cooperation with other Departments

The inspection department exists for the mutual protection of the manufacturer and the customer. The salesman should be informed in regard to the methods and practice of the inspection department, as this knowledge may be of great service in promoting friendly relations with a prospective or actual customer. The customer is often much interested in the means employed to insure accuracy in the manufacture of the apparatus he proposes to use. The head of the inspection department should therefore make it his duty to advise the sales department of any change in procedure or equipment that might be of interest to that department in its dealings.

The relations of the inspection department to the engineering department are most important, especially in the influence that may be exerted on the designs for new ap-

paratus and the improvement of the old. In many places, new drawings, when completed and before their final approval, are submitted to a committee (variously known as "mechanical design committee," "limit committee," "standard committee," etc.) to determine if the limits set by the designers are such as can be met commercially in the factory, and to decide if any changes are desirable on account of methods to be used in the foundry, machine shop or elsewhere. The head of the inspection department should be one of the most important members of this committee; in some instances he is chairman. His principal duty in connection with this committee is to advise if the dimensions, tolerances and limits called for on the drawings are satisfactory for the various fits and if the quality of finish called for will be satisfactory to the inspection department. Thus the work of the inspection department should begin even before the designs are approved for manufacture.

The internal organization of the inspection department and the means and methods best adapted to carry out the details of its work are matters that will depend to a great extent on the management and operation of the larger manufacturing organization of which it forms a part. A plan of organization that may be highly efficient in one factory may be deficient in meeting the needs of another shop producing a different product or producing a similar product by widely different methods. The organization of inspectors that is perfectly suited to a factory having a large output of a few well standardized articles would be wholly unable to cope with the situations arising in a smaller factory producing a great variety of articles, but making each in comparatively small numbers. It is obviously absurd to try to apply big-shop methods to a small shop, and the converse application, while far more usual, is no more logical. Such matters must, therefore, be subjects of careful investigation and study in each individual plant.

* * *

One of the leading manufacturers of gear wheels, designs these with webs for the smaller sizes and spokes for the larger. The points at which webs cease to be used and spokes are applied are given by the table below.

Diametral Pitch	Diameter, Inches	Diametral Pitch	Diameter, Inches
12-10	5	4-3	12
9	6	2½	14
8	7	2	16
7-6	8	1½	26
5	10		

STRAIGHT KEYS AND THEIR STRENGTH VALUES*

BY PERCIVAL K. REED†

Tables have been published at different times giving the proper width of straight keys to use with shafts of various diameters; these cover the range of general practice in machine construction, and are sometimes expressed in the form of an approximate ratio relating to the shaft diameters. The length of the bore of gear hubs or like members, in which the keys are located, is not so well defined, as the conditions of construction may vary it from three-fourths to four or five times the shaft diameter. Thus, while the strength of the shaft is constant for a given quality of material, and varies as the cube of the diameter, it is quite evident that to select a key of a width directly proportional to the diameter, without considering its length, would give a wide range of strength values for the same width of key in a shaft of given diameter. At times, this might result in serious failure, particularly where hubs of short lengths are used.

In the design and construction of machinery it frequently happens that an expensive train of mechanism must be placed in some inaccessible position. It will readily be understood that the failure of a key in such a train of mechanism would entail considerable loss in time and expense for dismantling and reassembling, and it is his ability to overcome trouble from just such conditions that enables the thorough and experienced designer to command a good salary. Under his instructions, such a mechanism would probably have been designed with considerable excess strength for each gear, shaft and key, with the single exception of some easily removable gear or other driving member at the external end of a shaft leading to the internal mechanism. Here the key should be designed to have a shearing fiber stress considerably higher than is generally allowed for safe driving, but still within the elastic limit of the material; this key will have sufficient strength to carry the rated load of this portion of the mechanism, but when some abnormal resistance is developed the key will be the weakest member and will naturally fail with a clean sheared fracture, thus sav-

* For other articles on the design of keys published in MACHINERY, see "Dimensions of Woodruff Keys," September, 1914; "The Square Key versus Rectangular and Tapered Keys," March, 1914; "Dimensions of Tapered Keys and Keyways," February, 1913; and "The Effect of Keyways on the Strength of Shafts," January, 1911.

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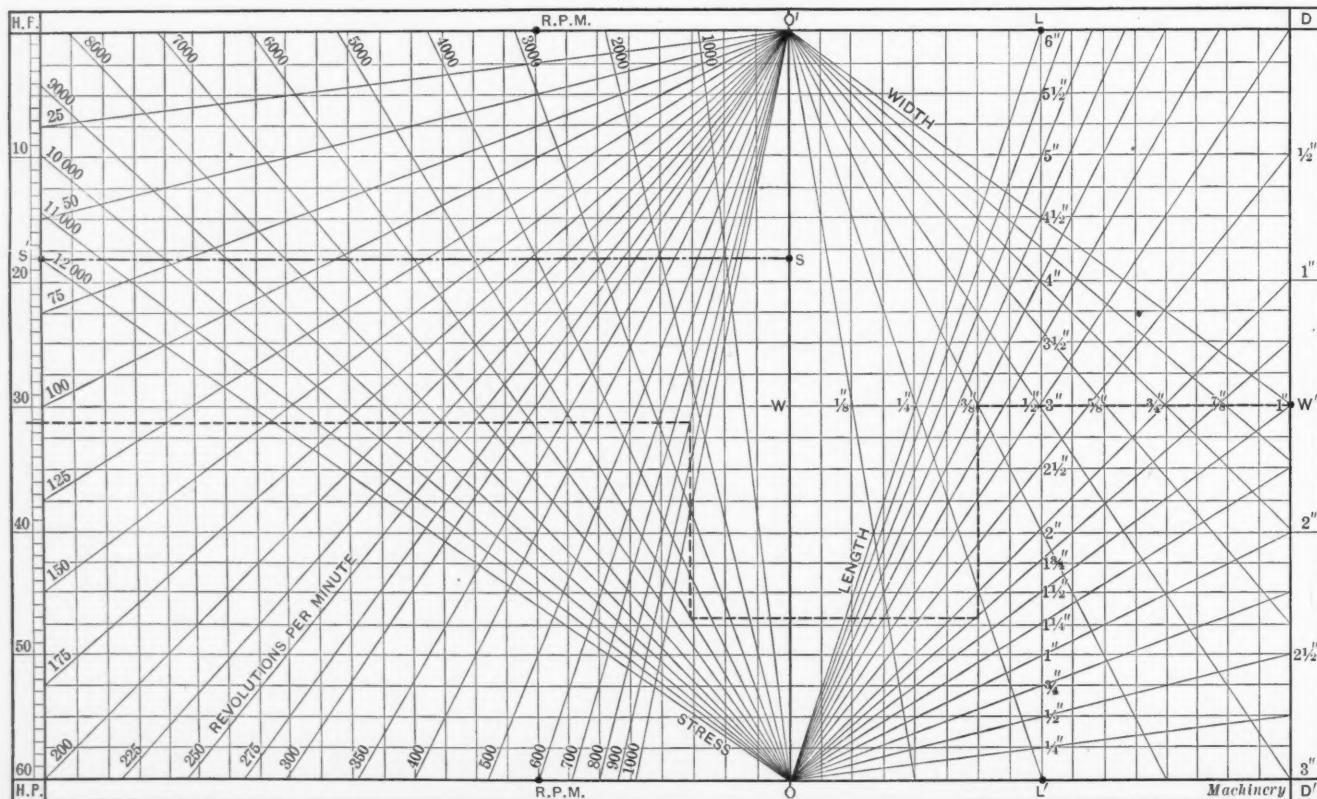


Chart for Use in determining or checking the Strength Values of Straight Keys

ing the more intricate portions of the machine from damage and materially reducing the time and expense required for making repairs. This is analogous to the application of the well-known principle of shear pins used for worm-wheel connections in feed-boxes, and is referred to in order to impress the reader with the importance of knowing exactly the strength of every key that is used, and of varying these values to meet the required condition, *i. e.*, to drive safely or to shear at a predetermined excessive load.

To assist in determining these values quickly and with a reasonable degree of accuracy, when due consideration is given to the six varying conditions of width and length of the key, diameter and revolutions per minute of shaft, horsepower to be transmitted, and allowable fiber stress in the key, the writer has arranged the accompanying chart, whereby the proper relation of these six elements may be obtained when a certain number of them are determined by considerations of design. To illustrate its use, let the chart first be applied in checking up the strength of a key in a 2-inch driving shaft turned down at the keyed portion to $1\frac{1}{2}$ inch in diameter; the velocity is 800 R. P. M., the key is $\frac{3}{8}$ inch wide by $1\frac{1}{4}$ inch long, and is intended to safely transmit 30 horsepower at a maximum fiber stress in shear of 5000 pounds per square inch. The method of procedure is as follows: First, find the shaft diameter D of $1\frac{1}{2}$ inch at the right-hand side of the chart. Then move horizontally to the left until the line intersects the diagonal line indicating the proper key width W of $\frac{3}{8}$ inch. Then move vertically until intersecting the diagonal line indicating a key length of L of $1\frac{1}{4}$ inch. Next pass horizontally into the left-hand chart until intersecting the line which represents a stress S of 5000 pounds per square inch. Then again move vertically to intersect the speed line for 800 R. P. M. By moving to the left from this point, the resultant horsepower will be found. The value obtained is 31.25 horsepower, thus showing the key to be well selected for the required duty, with a slight excess of strength.

When using the chart to determine an unknown element, when the remaining five are either known or assumed, it is only necessary to move forward from the first element and backward from the last element in the proper sequence, and the point of intersection of the projected horizontal and vertical determinant lines in the field of diagonal lines of the unknown element will determine the value of this unknown element. Should the combination of elements be such as not to conveniently lend themselves to projecting and intersecting on the chart, a nominal shaft diameter of 1 inch may be used, and the resulting horsepower multiplied by the actual diameter will give the proper value of the key. As a matter of fact, any one element may be reduced to unity and the resulting horsepower corrected in like manner by multiplication; also, if in finding an unknown element the duty is higher than the scope of horsepower of the chart, some portion of the duty, as one-half the actual horsepower, may be used. If the result is finally corrected by multiplying by the reciprocal of whatever reduction factor was used, proportionate values of the unknown element will be obtained.

For those who may be interested in the principle underlying the laying out of the chart, it may be explained as follows. Let:

- W = width of key;
- L = length of key;
- D = diameter of shaft;
- H.P. = horsepower;
- R.P.M. = revolutions per minute;
- S = shearing stress in key in pounds per square inch;
- P = total pounds stress in shear across key area;
- $A = WL$ = shearing area of key.

The stress considered is one of direct shear, which is the usual case for well constructed keys as proved by a close examination of actual cases of failure.

$$P = \frac{2 \times 63,000 \times \text{H.P.}}{D \times \text{R.P.M.}}$$

$$P = AS = WLS$$

$$WLS = \frac{126,000 \text{ H.P.}}{D \times \text{R.P.M.}}$$

$$\text{H.P.} = \frac{WLS \times \text{R.P.M.}}{126,000}$$

It will be noted that the horsepower varies directly as the product of the remaining five elements under consideration, divided by the constant 126,000. Substituting the values of the example referred to in connection with the chart, this expression will become:

$$\frac{0.375 \times 1.75 \times 5000 \times 1.5 \times 800}{126,000} = 31.25 \text{ H.P.}$$

This corresponds to the result indicated by the dotted line. The construction of the chart is based on the foregoing discussion, and is worked out as follows: The diagonal lines representing the key widths W are radial from point O' , and are laid out to proportional distances from line $O'O$ along line WW' . The values of the diameters D of the shafts are indicated by horizontal lines spaced in proportional distances from line $O'D$. Therefore points of intersection of lines representing D and W will fall at proportional distances from line $O'O$ and represent the various expressions of DW . Likewise, since lines representing the lengths L of the keys, radiate from point O and are spaced at proportional distances from line OD' along line LL' , the intersections of vertically projected lines from intersection points DW with diagonals representing the lengths L of the keys, will be at proportional distances from line OD' to the variable values of DWL . Projecting horizontally into the left-hand chart to intersect diagonal lines in the field of stress, which are radial from point O and spaced at proportional distances from line OO' along line SS' , the intersections will fall at proportional distances from OO' to give values of the product $DWLS$. A vertical projection from any such point intersecting one of the diagonal lines of R.P.M., which radiate from point O' and are proportionately spaced along line R.P.M., will determine the horsepower, because the distance of intersection will vary from the top of the chart as the product $DWLS \times \text{R.P.M.}$ varies, and this product includes all the variable elements in the foregoing horsepower formula, each element as it varies directly affecting the horsepower, as previously noted.

The horsepower have been indicated at the left-hand side of the chart on horizontal lines spaced at proportional distances from the top of the chart, so as to bring the calculated and plotted results in coincidence, corresponding to the formula, as has been shown by the example. Thus, since the equation is of the first degree, the chart must be approximately correct for all variables within the scope of its area.

When using the chart, it must be kept in mind that it concerns the key values only, and does not determine the relation between the strength of shafts and the horsepower to be transmitted, which is a different abstract problem that is not at present being considered.

* * *

RUSSIAN-AMERICAN TRADE JOURNAL

A journal devoted to Russian-American trade has been started by R. Martens & Co., Inc., 24 State St., New York City. The publishers believe that both Russia and America have much to gain from a better understanding of each other and from closer trade relations. It is the intention to publish in the journal material concerning Russia and the Russians that will be more interesting in a general way and more authoritative from the technical side than the information that is now obtainable in the English language. The journal will be issued monthly and will be sent without charge to all who are seriously interested in Russia and Russian trade opportunities.

* * *

German silver is known under probably a greater number of names than any other alloy. In addition to the name nickel-silver, it is also known as Chinese white silver or packfong, white copper, silveroid, Nevada silver, and electrum.

UNDER-CUTTING MACHINE WITH FINGER GUARD

BY DONALD BAKER*

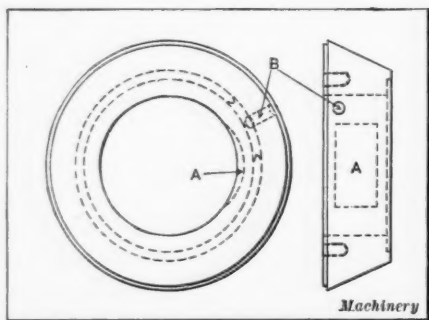


Fig. 1. Work to be under-cut at A

The piece shown in Fig. 1 is the timing ring of a fuse in which it is required to machine the under-cut A; and Fig. 2 shows an ordinary bench lathe equipped with a boring cross-slide, which is employed for performing the under-cutting operation. This bench lathe was originally used in the manufacturing department of a watch factory, but the addition of the fixture shown in place on the machine enables it to do this work very efficiently. Referring to Fig. 2, it will be seen that there is a stud A on the fixture, the end of which is hardened and ground to form a nose over which the work *a* is located, while the opposite end of the stud is threaded and screwed into plate B; the end of the stud extends back into the boring head and slide C. When plate B has been located in the proper position, it is secured in place by a dowel-pin D. This plate B also carries two studs E which act in conjunction with the swinging clamp F to hold the work in place on the nose of stud A. Clamp F is made of tool steel, and is hardened and drawn to a spring temper at points G. The clamp has been cut away at these points to give it sufficient spring to allow for slight differences in the thickness of the work, which may amount to as much as 0.010 inch.

The work is located in the fixture by a plunger H, which enters hole B (Fig. 1). The arrangement of this locating device will be understood from the front view of the fixture shown in Fig. 2 and the detail view Fig. 3, where it will be seen that the locating pin is operated by lever J which fits over pin K and forces back bar L that is a continuation of the locating pin. The drawing back of the pin is resisted by flat spring M that serves the additional purpose of a cover plate over the bar that carries pin H. Pin N enters a slot in the bar L and limits its movement so that it is impossible to break spring M. This is shown clearly in Fig. 3.

In operating this machine it was found that so little room had been provided between the cutter and the work that the workman was likely to hurt his fingers while putting the work in place in the fixture, even though the cutter was not rotating. To eliminate this danger and also to permit running the cutter continuously, the machine was equipped with a finger guard shown at P. This guard is made of a piece of flat stock with a ring which surrounds the cutter and projects past it for a sufficient distance to make it impossible for a man's hand to come in contact with the cutter while the guard is in its outermost position. Bushing Q is pressed into the lower part of the guard and is a sliding fit on pin R, while spring S holds the guard in its outer position. Pin T serves as a further

guide for the guard, and crosspin U limits its travel. It will of course be evident that when the work is fed up to the cutter, lower stud E comes into contact with guard P and pushes it back against the resistance of spring S so that the cutter may enter the hole in the work.

The operation of the machine is as follows: Locating pin H is drawn back by means of lever J so that the finished piece may be removed from the stud A and a fresh blank substituted. Lever J is then released to allow the locating pin to drop into position in hole B in the work, after which clamp F is brought up into position over the work so that it is secured in place on the nose of the fixture. Movement of slide C, which is governed by a hand-lever, brings the work into position over the cutter, and guard P is moved back, as previously described. When the work has been brought to the limit of its forward travel, which is governed by a stop on slide C, the work is fed against the cutter by operating lever V which actuates cross-slide W, the movement of this slide being limited in either direction by stop screws X. The capacity of this machine is for from 3000 to 4000 pieces per ten-hour day, although under the best conditions as many as 100 rings have been under-cut in ten minutes.

* * *

Engineering schools have successfully taught the laws of materials and forces and the methods of adapting these materials and forces to the use of man, but they have almost entirely disregarded the human element—a knowledge of which is absolutely essential for the proper utilization of any mechanisms which the engineer may contrive.

If we would direct successfully the operation of any mechanism, we must have as complete knowledge of the men who are going to operate it as we have of the mechanism itself. * * * Without an intimate knowledge of the workman, a college graduate is too likely to assume, because the workman has not the same kind of knowledge that he has, that he is necessarily ignorant and a fit subject for contempt. A little association with him, however, soon dispels this idea, for the college man finds out that although the workman's knowledge may be quite different from the knowledge that he has, it is very extensive, and embraces subjects of which he is entirely ignorant. The workman has indeed a great deal of knowledge, much of which is far more practical and better suited to his needs than that which the college man can give him. The workman recognizes that the college man knows little about those subjects with which he is most familiar, and he is likely to have more contempt for the college man than the latter has for him.—H. L. Gantt, in *Industrial Leadership*.

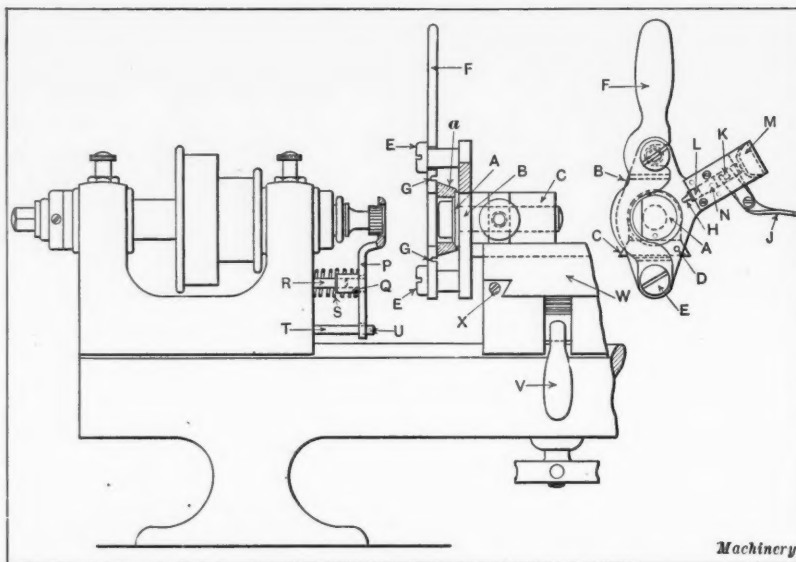


Fig. 2. Bench Lathe with Boring Cross-slide equipped for under-cutting Fuse Parts

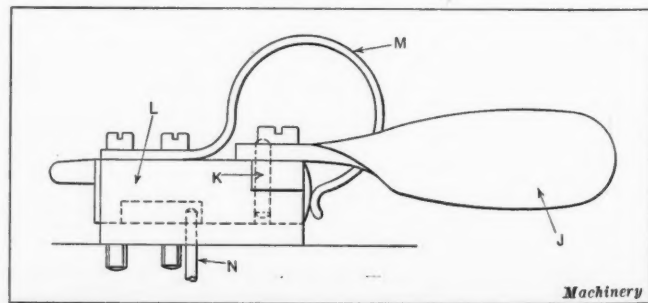


Fig. 3. Detail View of Mechanism for locating Work on Fixture

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Tool System of Cadillac Motor Car Co.-I

by
Edward K Hammond



THE development of an efficient system for the purchase of tools and accounting for them after delivery to the shops is one of the difficult problems which the management of every large factory has to work out. There are various requirements to be fulfilled. In the first place, the men in all departments of the factory must be kept supplied with the tools and supplies needed to carry on their work. Second, the tools must be of the type and quality which will do the greatest amount of work for each dollar expended. Third, they must be purchased in a way that insures obtaining the most advantageous price. Fourth, a careful record must be maintained to see that they are not stolen or needlessly damaged. Fifth, accurate accounts must be kept of all tools delivered to each tool supply room in order that they may be charged up to the department using them, when worn out or broken.

After grasping the different phases of this problem, it will be evident that the man who can administrate the tool service department of a large factory must have a variety of qualifications. He must be systematic, for there are a multitude of details to attend to and records to maintain. It is important for him to be a trained mechanic in order to know which tools are capable of giving the greatest amount of service for each dollar spent. Last, though by no means least, he should possess a sufficient knowledge of accounting to see that all charges made against all departments and credits in favor of them are correct. The system used in the maintenance supplies and tool service department of the Cadillac Motor Car Co., Detroit, Mich., was worked out by A. D. Elmer to meet the requirements of this company's factory, but it is capable of application, with slight modifications, in any large manufacturing plant. This system represents scientific management at its best; that is to say, the routine work and accuracy of scientific

methods of management have been applied in a way which has eliminated all unnecessary detail or features that would tend to retard the rate of production in the shops. We are indebted to George W. Walker, assistant to Mr. Elmer, for the material which forms the basis of this article.

Before entering upon a detailed description of the work of the maintenance supplies and tool service department, it will be well to give the reader an idea of just what relation this department bears to the manufacturing departments of the factory. Briefly stated, it may be said to constitute a central distributing station for all tools and supplies used in the performance of manufacturing operations on parts of Cadillac motor cars; although it is important to note that this department does not have jurisdiction over materials which enter into the construction of cars. But the handling of tools and manufacturing supplies is only a part of the work of this department. In addition, it acts in an advisory capacity to the purchasing department by specifying the classes of tools and materials which are to be purchased. The importance of this plan is that the head of the department is a trained mechanic and is able to order the type of tools or class of supplies which is best suited for the particular purpose to which it is to be put. The maintenance supplies and tool service department is held responsible for the quality of all tools and supplies which are delivered to the factory. For this purpose it has a corps of inspectors in addition to a fully equipped chemical and physical laboratory; and all tools and supplies are either inspected or tested before being accepted, so that positive assurance is obtained that their quality is satisfactory. The relationship of the maintenance supplies and tool service department to other departments of the factory is shown diagrammatically in Fig. 1.

The material handled by the maintenance supplies and tool service department is divided into three general classifications as follows: first, "long-lived tools," which are under-

For other articles on shop systems, see "Shop System of the American Machine & Foundry Co.," February, 1915, and articles there referred to.

stood to be tools which have a working life of considerable length; second, "short-lived or consumable tools," which is the name applied to a great variety of tools used for manufacturing purposes that are not capable of being used for any long period, drills, taps, dies, files and hacksaw blades being typical examples; third, "manufacturing expense supplies," which are such materials as sandpaper or sponges.

How the System is Operated

For the purpose of giving a detailed description of certain

features of this system, we will assume that the foreman in one of the departments of the factory finds himself in need of a number of some type of tools which has not been previously used in the factory. To obtain such tools he must make application to the maintenance supplies and tool service department for them, explaining for what purpose the tools are to be used. This application will be turned over to one of the inspectors of the department, who is a mechanic of wide experience, and it is the duty of this man to decide, first, whether the foreman has need of the tools for which he has made a requisition, and second, whether the tools which he specifies are those best suited for the purpose. If the inspector reports favorably on the foreman's application, the maintenance supplies and tool service department will issue a "T-requisition" for the purchasing department, authorizing the buying of a specified number of the tools in question. In writing this T-requisition, use is made of the form shown in Fig. 2. Six copies are made out which are marked first copy to sixth copy, inclusive, but which are otherwise virtually the same, so that only one copy is illustrated. Attention is directed to the fact that in the lower left-hand corner of the form there are places for a T-requisition number and a purchase order number, but an arrangement has recently been made whereby the "T. No." is used as the "P. O. No." At the same time that the T-requisition is made out, an entry is made on a white order card, shown in Fig. 4, and the pink copy of the requisition is stamped "Entered on Order Card," to show that the order has been issued. This card also records the receipt of tools.

The use of the six copies of the T-requisition issued on the purchasing department is as follows: The first is sent to the purchasing department as authority to buy. The second

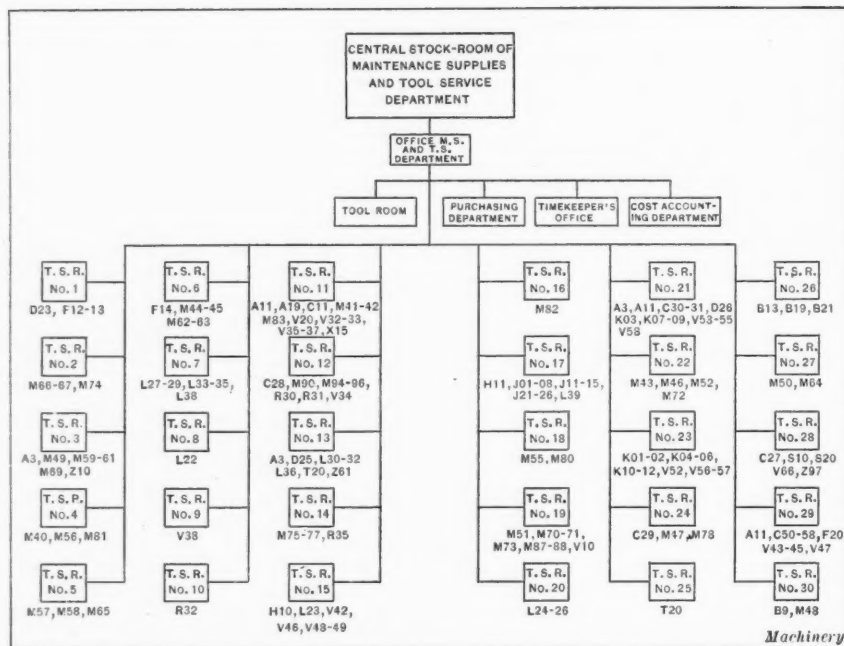


Fig. 1. Diagram showing Relationship of Maintenance Supplies and Tool Service Department to Other Departments of Factory of Cadillac Motor Car Co.

copy is filed by the tool tracer in the maintenance supplies and tool service office on a file labeled "unfilled orders" until such time as the order has been completed, as explained subsequently. On the back of this copy the tool tracer records all correspondence, and notes progress being made in filling the order, which information is available to all interested parties. The third copy is held on the inspector's file until the tools are received, to serve as a notice that he has these tools to inspect, and after receipt and inspection of the tools the inspector's copy of the T-requisition is destroyed. The fourth copy is sent to the foreman of the department who ordered the tools to notify him that his order has been taken care of and will be filled in due course. It was stated that the form of all copies of the T-requisition is virtually the same, but in the case of the fourth copy which is sent to the foreman, information is given in regard to the clerks in the maintenance supplies and tool service department to whom written or telephone messages should be addressed in making any inquiries in regard to the tools in question. The fifth copy is given to the tool tracer whose duty it is to follow up the job represented by the T-order to be sure that satisfactory progress is being made in filling it. The sixth copy, which is sent to the cost accounting department, is filed by order number so that the invoice may be properly classified when the goods are received.

For the drills called for on the order shown in Fig. 2, it will be seen that the invoice would be classified under account No. 58. The cost accounting department also makes out a cost card which is used for reference in pricing worn out tools when they are released, as will be explained later.

Receipt of New Tools in the Factory

At the time that the new tools are delivered to the factory, the receiving department makes out five copies of the receiving slip shown in Fig. 3, three of which are sent to the maintenance supplies and tool service department together with the goods. The first copy is signed and returned to the receiving department, where it is filed according to date and name of the firm which supplied the tools, serving as this department's receipt for the goods which it has sent out. The second copy is kept with the goods until they have been inspected; and if they are found to be O. K. and the

2ND COPY

DEPARTMENT NO. 43-1-23

Date _____

Order From _____

QUANTITY	MATERIAL	ACCOUNT
144 -	1/2" Taper Shank High Speed Drills.	

DELIVER TO DEPARTMENT D-24

58

Dept. D-24

ENTERED ON ORDER CARD

Per *W. M. L...*

COMPLETED

DATE 4-26-16

By *W. M. L...*

No. T 38780 Deliver to Dept. D-24

P. O. No. _____ Notify *Wm. Durdan. Dept. M. 66*

Fig. 2. Form used in authorizing Purchase of Tools and Maintenance Supplies; Size 7 by 8 1/4 Inches; Six Copies required, which are made out on Yellow, Red, Blue, White, Green and Pink Stock

copy of the receiving slip conforms with the inspector's copy of the T-requisition (Fig. 2) the receiving slip is signed by the inspector and attached to the inspector's copy of the T-requisition. These slips, together with the tools, are then sent to the stock-room, where the balance in stock is added to the quantity received, and noted on receiving slip as indicated by the ninety in a circle in Fig. 3. This

is used as a check against the balance which appears on the stock card. The stock-keeper then signs the receiving slip and notes the location of the tools in the stock-room under the space provided for remarks; and this second copy of the receiving slip, together with the inspector's copy of the T-requisition, is then handed to the tool tracer to notify him that the tools have been delivered to the stock-room. The tool tracer destroys the inspector's copy, attaches the pink copy to the receiving slip and hands them to the file record-clerk, who is then ready to close the order card, Fig. 4, and make the proper notations on the stock card, Fig. 5. He then stamps the receiving slip "Posted" and files it by the T-requisition number. The third copy of the receiving slip goes to the foreman of the department for which the tools were ordered, to notify him that these tools are in the stock-room. The pink copy of the T-requisition is stamped "Completed" and filed by the T-requisition number for future reference.

How Different Classes of Supplies are Identified

For the purpose of keeping accounts, each different class of tools or maintenance supplies is charged to a different account and these accounts are all designated by numbers. Fig. 4 shows the card on which the order is entered at the time that a T-requisition is sent to the purchasing department, authorizing it to buy the supplies called for. It will be seen that the order card has spaces at the top for entering the name, description and size of the tool, and the account number to which it is to be charged; also, that the lower part of this card provides spaces for noting the dates on which the tools are received, the T-requisition number which goes in the column headed "Req. No.", the number ordered, number received and balance due. The column headed "Bal. Due" is filled out in cases where a considerable number of tools are ordered and where the immediate necessity for these tools makes it advisable to have them delivered in installments. In

NAME		DESCRIPTION		ACCT. NO.
Drills		Taper Shank, High Speed		58
		SIZE		
		1/2"		
DATE	SENT TO DEPT.	REQ. NO.	ORDERED	BAL. DUE
4-24-16	524	T-38781	144	
4-26-16	"	"		
			60	84
			84	0

Fig. 4. Form of Card used for recording Order and Receipt of Tools and Supplies; Size 6 by 4 Inches; One Copy made out on White Stock

REC'D FROM		RECEIVING SLIP NO.	
T 38781		DATE April 24, 1916	
PRO. NO.	AM'T CHGS.	WT.	INITIAL
NO. BOXES, PKGS., ETC.		CAR	NUMBER
POSTED Jos. Viehoff. Per.....			
PURCH. ORDER	QUANTITY	PART NO.	DESCRIPTION
T 38781	60		1/2" Taper Shank High Speed Drills
REMARKS: Drawer 60			
DELIVER TO DEPT. P-24			
H. F. M. Higby.			
H. S. Tuckett.			
(90)			

Fig. 3. Form used by Receiving Department for recording Receipt of Tools and Supplies; Size 8 1/2 by 5 Inches; Five Copies required, which are made out on White Stock

mediately be issued for the necessary number to bring the supply on hand up to the maximum quantity. It will also be noted that the location of this particular tool in the tool stock-room is entered beside the heading "Location." The arrangement of the card will be self-evident with the exception of the columns headed "In," "Out" and "Balance." Each time new tools are delivered to the stock-room the number received is recorded in the "In" column, and similarly each time tools are sent out to one of the tool supply rooms the number sent out is recorded in the "Out" column. By adding to or deducting from the previous balance number, the existing balance on hand is found and recorded in the column provided for that purpose.

A record of receipt is made on the stock card shown in Fig. 5 at the time the tools are delivered to the stock-room. The order and stock cards are kept in filing cabinets in the office of the maintenance supplies and tool service department. At the time that the receipt of new tools is recorded on the stock card, a corresponding entry is made on a stock bin card, shown in Fig. 6. Cards of this type are held in clips on each of the bins, and contain a record of the number of tools in the bin; the records on these cards also serve as a check on the records of the balance which appears on the stock cards. The manner in which this card is filled out will be evident after having read the description of the stock card.

How the Foreman Proceeds in Ordering Tools

The maintenance supplies and tool service department has a central stock-room to which all new tools and supplies are sent at the time they are delivered to the factory; and distributed around the plant are a number of sub-departments known as "tool supply rooms" which act as middlemen in the transfer of tools from the main stock-room to the different departments of the factory. The men in the factory go to the tool supply rooms for anything they need; and when

NAME		DESCRIPTION		ACCT. NO.
Drills		Taper Shank High Speed		58
		SIZE		
		1/2"		
MIN.	ORDER	LOCATION		BALANCE
30	144	Dr. 160		
DATE	REQ. ORDER NO.	T. S. R. NO.	IN	OUT
3-29-16				30
3-29-16	T 38781		96	126
4-1-16	"		48	174
4-6-16	H 7540	6		126
4-12-16	H 8312	4		66
4-18-16	H 2200	12		30
4-24-16	T 38781		60	90
4-26-16	"		84	174

Fig. 5. Form of Card used for recording Amount of Stock on Hand in Central Supply Room; Size 6 by 4 Inches; One Copy made out on Pink Stock

any case, this card shows the condition of the last order issued for tools of the particular type to which it refers. The stock card, Fig. 5, is the same as the order card except for the two spaces on the left marked "Min." and "Order." This refers to the the number of tools of this kind which must always be kept in stock, and when the number has been reduced to this minimum it means that an order must im-

NAME <i>Drill</i>		SIZE <i>1/2"</i>		Form 1113	
KIN <i>Taper Shank High Speed</i>		LOCATION <i>Dx 160</i>			
NO.		CLASSIFICATION <i>58</i>			
DATE	ORDER NO.	IN	OUT	BALANCE	REMARKS
3-29-16	<i>Bal. Forwarded</i>			30	
3-29-16	<i>734873</i>	96		126	<i>Q. 8</i>
4-1-16		48		174	<i>Q. 8</i>
4-6-16	<i>71540</i>		48	126	<i>Q. 8</i>
4-12-16	<i>78312</i>		60	66	<i>" 4 1/2"</i>
4-18-16	<i>718800</i>		36	30	<i>" 1/2 B.D.</i>
4-24-16	<i>738780</i>	60		90	<i>Q. 8</i>
4-26-16	<i>"</i>	84		174	<i>Q. 8</i>

Fig. 6. Form of Bin Card used to record Number of Tools in Bins; Size 5 by 3 Inches; One Copy made out on White Stock

the attendant finds that his stock of any tool is running low, which seldom happens due to automatic replacement each week of broken and worn out tools, as fully explained subsequently, he sends up to the central stock-room for more. In making requisition for supplies, use is made of the form shown in Fig. 7, which is made out in duplicate and sent up to the maintenance supplies and tool service department by a messenger. Both copies are handed to one of this department's inspectors, who passes upon the propriety of the requisition, and is found O. K., sends it to the stock-room where an order number is assigned to the delivery of tools, after which the proper entry is made on the bin card and the tools called for are handed to the messenger who takes them back to the tool supply room.

At the time that the tools are removed from the bin, a proper entry is made on the card held in the clip on this bin to show the balance which still remains on hand; and the requisition slip is stamped "Filled" on back. The first copy

C. P. 111 2-16		MATERIAL TRANSFER <i>OK/106</i>	
DATE <i>April 18, 1916</i>		STORE ROOM ACCOUNTS	
		NO. <i>71-8800</i>	
QUANTITY	DESCRIPTION	PRICE	AMOUNT
36	<i>1/2" Taper Shank High Speed Drills</i>		
	(30)		
FROM <i>D-24</i>	TO <i>D-31-T.S.R. #2</i>		
BY ORDER CLASS <i>58</i>	STORES CL. <i>58</i>		
SIGNED <i>H. McLaren</i>			

Fig. 7. Form used by Foreman in making Requisition for Tools and Supplies; Size 3 by 5 Inches; Two Copies made out on Yellow Stock

of the requisition is sent on to a requisition clerk who enters the item in the "Requisitions Filled" book. This book is maintained to be sure that all requisitions are properly accounted for, and does away with the possibility of lost requisitions. One copy of the requisition goes to the file record-clerk to make the proper entry on the stock card and figure the balance on hand; and finally, the requisition slip goes to the cost accounting department, where the proper adjustment of accounts is made and the slip filed by its order number. It will be noticed on this slip that there is a number 30 with a circle drawn around it, which represents the number of tools that remain on hand after the order has been filled. When the slip reaches the file record-clerk, he calculates the balance on hand from the data on the stock card and the balance obtained must agree with the number on the requisition slip; otherwise, an investigation will be instigated to determine the cause of the discrepancy.

When the tools are given to the messenger to take to the tool supply room, a list of the tools is made on the form shown in Fig. 8, to which has been assigned the same order number as shown on the requisition, and the messenger signs this form with the name of the foreman of the tool supply

room to which the tools are going, together with his own initials. This form is filed in the maintenance supplies and tool service office by requisition number and serves as a receipt for the tools that have been sent out. At the time the tools are sent from the central stock-room to the tool supply room a slip of the form shown in Fig. 9 is made out and sent to the foreman to notify him that the tools he needs are in his tool supply room ready to be drawn out on the workmen's tool checks. When tools are received in the tool supply room they are entered in a book known as the "Incoming Commercial Tool" book, which shows date received, requisition number, quantity and description of the tools, and contains spaces to be used by the tool supply room man and clerk for checking when cards are put in the card file and spaces assigned on the check board.

The second copy of the requisition slip, Fig. 7, goes to the tool supply room record-clerk who makes an entry on cards

N-8800		Date <i>April 18, 1916</i>
Received from		DEPT. NO. <i>D-24</i>
<i>36-1/2" Taper Shank High Speed Drills</i>		
Sign here <i>H. McLaren</i> <i>Per D.M.</i>		

Fig. 8. Form used by Messenger in signing Receipt for Tools or Supplies sent to Tool Supply Room; Size 6 by 4 Inches; One Copy made out on Orange Stock

of the form shown in Fig. 10. These cards are made out in duplicate on red and white stock; the white copy is filed in the maintenance supplies and tool service department and the red copy in the tool supply room. On the day following the delivery of the tools, the second copy of the requisition slip is taken to the tool supply room, where the entry is made on a card, Fig. 10, to record delivery of the tools to the tool supply room. At the same time, the clerk checks the "incoming commercial tool" book to show that the proper entry has been made on the card, Fig. 10. Later the man who has charge of the check boards also checks the book to show that a space has been assigned to the tools on the check board.

Report to the Office

It has been explained that on the day after the tools are sent from the central supply room to one of the tool supply rooms, a clerk takes the second copy of the tool supply room

Commercial Tool Notice		
Date <i>April 18, 1916</i>		
Mr. <i>Winne</i>		
This is to notify you that		
AMOUNT	SIZE	ARTICLE
36	1/2"	<i>Taper Shank High Speed Drills</i>
Is in Tool Supply Room No. <i>12</i>		
Signed <i>W. Elmer</i> <i>D. B. D.</i>		

Fig. 9. Form used by Central Stock-room in notifying Foreman of Delivery of Tools to his Tool Supply Room; Size 5 1/2 by 4 1/4 Inches; One Copy made out on Orange Stock

foreman's requisition slip and makes an entry on the card file in the tool supply room. It will also be recalled that the man in charge of the check board sees that a space has been provided for the tools so that they may be checked out to a workman. Similarly, if tools are removed permanently, the tool supply room records must show that such tools are no longer available. Each tool that goes out of a tool supply room is entered in a book known as the "Outgoing Commercial Tool" book which shows the date on which the tools were removed and the quantity and description of the tools, together with spaces to be used by the clerk to check when removing cards, check-board man to check when check board has been corrected and tool supply room man to cross-check when book and work are O. K. Once a week the books of each tool supply room are gone over by the man in charge to see that they are checked up to date. In reporting conditions

DATE	ORDER NO.	IN	OUT	BALANCE	REMARKS
4-18-16	75800	36		36	H.M.

Fig. 10. Form of Card used for recording Transfer of Tools and Supplies from Stock-room to Tool-rooms; Size 3 by 5 Inches; Two Copies made out on White and Red Stock; White Copy filed in M. S. & T. S. Office and Red Copy in T. S. R.

found in each tool supply room, he uses the form shown in Fig. 11. It will be seen that the form used for this purpose provides a space for the number of the tool supply room to which the report refers, and spaces for the date and the tool supply room man's signature. In the space on the form, information is given concerning the order number, the number of tools, with their size and description, after which a check mark is placed in one of the three vertical columns at the right to show if a tool has been sent out without being credited, if it has come in without being charged, or if no space has been provided on the check board for the tools in question. In each case, the date of the transaction is recorded in the column at the extreme right. The making of these reports to the office enables the work of each tool supply room to be accurately checked up, and if it is found that any of the clerks show a tendency to be lax in their work, the necessary steps can be taken to overcome the difficulty.

Examining the Records to Guard Against Shortage

It has already been explained that a minimum number is assigned to each class of tools and supplies, and recorded on the stock card in the space assigned for that purpose. When

Order No.	Amount	Size	Name of Tool	Not Charged	Not Credited	Not On Board	Date
75810	2	10"	Star Neck saw frame	✓		✓	4-16
75812	4	14"	Solid Hand. Hammers	✓		✓	4-16

Fig. 11. Form used by T. S. R. Foreman for recording Conditions of Files and Check Boards in Tool Supply Rooms; Size 8 1/4 by 5 1/2 Inches; One Copy made out on Pink Stock

ORDER AMOUNT	SIZE	ARTICLE	AMOUNT IN STOCK	MIN. AMT	AMT ON HAND	CHANGE MIN AMT TO	CHANGE ORDER AMT TO
144	1/2"	Taper Shank High Speed Drills	30	30	30	-	-

Fig. 12. Form used by Inspector in calling for the Purchase of Additional Supplies; Size 6 by 4 Inches; Three Copies made out on Salmon, White and Yellow Stock

the file record-clerk, in the course of making deduction for tools sent out, finds that any article has reached the minimum amount he fills out the form shown in Fig. 12, one copy of which is passed to the inspector to determine whether or not the article is to be re-ordered. His knowledge of conditions in the factory is such that he can anticipate requirements and thereby control maximum quantities to carry in stock. If he finds that an order should go through, he O. K.'s his copy of the form shown in Fig. 12, and hands it to one of the stenographers to make out a form, Fig. 2, authorizing the purchasing department to buy more articles of this particular class. The form shown in Fig. 12 is made out in triplicate; the first copy is used by the stenographer, as previously mentioned, and is finally filed by the T-order number, which is written on the form shown in Fig. 2. The second copy is held by the record-clerk until the T-order has been written, after which it is destroyed. Before the first copy is filed, it is attached to the T-order form which has just been made out,

QUANTITY	DESCRIPTION	PRICE	EXTENSION
1	Barrel Soda Ash 180#		

Fig. 13. Form used by Foremen in making Requisition for Manufacturing Expense Supplies; Size 6 by 4 Inches; One Copy made out on Yellow Stock

and sent to the record-clerk who makes the necessary entry on the order card shown in Fig. 4. The third copy of the form shown in Fig. 12 is sent to the stock-room for the purpose of checking the balance recorded on the stock card against the number of tools actually in the bin, in order to be sure that these two coincide. The third copy is then returned to the office and filed by its card number 2852 for reference.

Method of Drawing Manufacturing Expense Supplies from Central Stock-room

The materials used in the factory which come under the classification "manufacturing expense supplies," that is to say, supplies which are rapidly consumed, are ordered out from the central stock-room on requisition slips of the form shown in Fig. 13. It will be seen that this slip provides for giving a description of the material, amount used, and cost, together with the purpose for which the material is to be used; and that spaces are provided for crediting the central stock-room

No. 17951 Name <i>Edw. McLeod</i> Dept. <i>M-47</i>	Date Issued	Date Returned
	<i>Apr. 3, 1916</i>	<i>Fifteen (15) Tool Checks</i>
		<i>1/2 Pint Oil Can</i>
		<i>#8 Sash Tool</i>
		<i>1 3/4" Cold Lead Hammer</i>

Fig. 14. Form of Card used by T. S. R. to record Tool Checks and Tools given to Workmen; Size 7 by 3 1/4 Inches; One Copy made out on Drab Stock

with this amount of material and charging it against the department in which it is actually to be used. Before any manufacturing expense supplies can be sent out from the central stock-room, the requisition must be O. K'd by the inspector and an order number must be assigned by the stock-room for purposes of identification. When the requisition is filled, the messenger signs a receipt for it, as in the case where an order is filled for tools, the form shown in Fig. 8 being employed for this purpose. The transaction is entered on the requisition record book by order number and the requisition slip, Fig. 13, is sent to the stock record-clerk for adjustment of the stock cards, and then to the cost accounting department, where the proper adjustment of the accounts is made to cover the transaction.

Drawing Out Tools from Stock Supply Rooms

In the Cadillac Motor Car Co.'s shops, the usual check system is employed for lending tools to the workmen. When a man comes to work he is usually given fifteen tool checks, but this number would not be sufficient to enable him always to get the number of tools required for his work if he had to take out all tools from the tool supply room on check. For the purpose of partially overcoming this difficulty, it has been found advisable to lend each man a certain standard set of tools—according to the work for which he is employed—and have these recorded on a card instead of lending them to him against tool checks. For this purpose cards are employed of the form shown in Fig. 14, and it will be seen that on these cards the first entry is "Fifteen Tool Checks," together with the date on which they were given to the workman. Standard tools may also be lent to the man and entered on this card, and should it happen that he returns any of the tools before leaving the company, the date on which the tools were returned is recorded in the column provided for that purpose, such a record constituting a cancellation of his responsibility for the tools in question. These cards are an important factor in preventing the theft or loss of tools, because before a man can be paid off when leaving, he must first get his tool account O. K'd by the foreman of the tool supply room which serves the department in which he was employed.

After the tool supply room foreman has gone over the tool account of a man who is leaving, he fills in a time office release form, Fig. 15. If the account is found to balance properly, the fact is noted, but should it happen that certain tools are missing these are noted in the space at the bottom. That part of the cost of lost tools which is to be charged to the employee is determined by the general foreman of the tool supply rooms, who notes it on the release, together with the account numbers of these tools. As a matter of fact, employees are seldom called upon to pay over half of the original cost of the tool; frequently it is less than this amount. In the upper right-hand corner of the form there is a space for noting the difference between the original cost of lost tools and the amount which the workman paid, this difference being charged against the department in which the tool was used. This form is made out in triplicate. The first copy is sent by messenger to the time office, the second copy is held by the tool supply room foreman until he gets credit for tool shortage on release and for future reference, and the third copy is held by the tool supply room general foreman as a memorandum

to assist him in seeing that he gets proper credit for his tool supply room in case of shortage.

Weekly Replacement of Worn Out and Broken Tools

If a man has a tool out on check and breaks the tool or wears it down to a point where he finds that it is no longer giving satisfactory service, he takes the tool to the foreman of his department and gets him to sign a tool release slip which will enable him to return the damaged or worn out tool to the tool supply room and get another tool or his check in exchange for it. For the purpose of releasing tools in this way, the foreman makes use of the form shown in Fig. 16, and when this form is turned in, an investigation is conducted to see if the supply of this particular kind of tool has been reduced to a point where more should be ordered. This work is done by the foreman of the tool supply room, and after he has reached a decision he draws his pencil either through the word "yes" or "no," leaving an affirmative or a negative to express his decision in regard to the necessity of replacement. These damaged tools, together with the foreman's release slips, are placed in a box in the tool supply room, and once a week an inspector goes around to look them over and decide whether or not the damage in each case is of a nature which justifies discarding the tool. In doing this work use is made of the replacement checking list shown in Fig. 17; the name of the inspector and the foreman of the tool supply room work, and the name and size of each tool which is found to be damaged beyond repair is entered on this list, the tool supply room foreman signing in the column at the left and the inspector in the column at the right.

The tools are then sent to the tool salvage department of the central stock-room and an alphabetical list of the tools is made out from the slips, the form shown in Fig. 19 being used for this purpose. This form is made out in triplicate. The first copy is a record for the files of the maintenance supplies

TIME OFFICE RELEASE		Form 1246		No. 14702	
This is to certify that <i>Edw. McLeod</i>		CHARGE DEPT. No.		<i>M-47</i>	
Clock No. <i>17951</i>		has settled his account with			
Tool Supply Room No. <i>24</i>		Dept. No. <i>M-47</i>		Classification <i>40 20</i>	
SHORTAGE				TOTAL <i>20</i>	
AMT.	ARTICLE	COST	Chg. Employee	CLASSIFICATION	
<i>3</i>	<i>Tool Checks</i>	<i>15</i>	<i>15</i>	<i>66</i>	
<i>1</i>	<i>1 1/2" Ball pin Hammer</i>	<i>60</i>	<i>40</i>	<i>40</i>	
Credit <i>10-31</i> Stock		TOTAL	<i>75</i>	<i>55</i>	
Date <i>April 20, 1916</i>		Signed		<i>E. A. Howell</i>	
TIME OFFICE COPY					

Fig. 15. Form used by Tool Supply Rooms in issuing Tool Release to Employees who are leaving; Size 6 1/4 by 4 1/4 Inches; Three Copies made out on White, Buff and Pink Stock

COMMERCIAL TOOL RELEASE		Form 1234	
T. S. R. No. <i>6</i>		Dept. No. <i>M-44</i>	
Release Check No. <i>M-4461</i> on the following Articles:			
AMT.	SIZE	ARTICLE	Am. Chg'd to Room
<i>3</i>	<i>1/8"</i>	<i>S. S. H. S. Drills</i>	<i>24</i>
For use in D-31-32-33-34		Date <i>April 8, 1916</i>	
Replace	Yes	Foreman <i>B. E. Snow</i>	
	No		

Fig. 16. Form used by Foremen in giving a Release for Tools which have been broken or worn out; Size 5 by 3 Inches; One Copy made out on White Stock

and tool service department; this is also used in making a replacement of tools in the tool supply room or crediting the room with the number of tools which are not replaced. This first copy is given to an inspector for O. K., and then it goes to the stock-room foreman, who looks after sending out tools to replace the broken ones; then it is sent to the record-clerk in order that the card in his file and the tool supply room card, both of which are of the form shown in Fig. 6, may be corrected for any tools that may not have been replaced; this first copy is then filed in the maintenance supplies and tool service department by order number. The second copy is returned to the tool supply room, where it is checked against the original list shown in Fig. 17 to see that the tool supply room has received tools to replace those sent out in a broken or damaged condition. The third copy goes to the cost accounting department in order that the stock-room may be credited with the tools and a corresponding charge made against the department in which they were broken.

If it happens that the foreman of one of the tool supply rooms has reason to believe that any man in the factory has checks representing tools which he has broken or lost, it is the privilege of the foreman of the tool supply room to call upon the man for a settlement of his tool account. For this purpose use is made of the form shown in Fig. 18, the use of which will be apparent from the illustration. This practice of calling upon the men for an accounting at any time that it may be deemed advisable is a great help in doing away with disputes over the accuracy for charges for tools which may be made against a man at the time he leaves the company.

Records of Tools Lent to Outside Firms

The Cadillac Motor Car Co. follows the generally used practice of having certain classes of work done by outside concerns in order to benefit by the experience of specialists in unusual lines of manufacture. This is particularly true of

[illegible]

Fig. 17. Replacement Checking List used in Tool Supply Room to record Tools which Inspection has shown to be Unsuitable for Further Use; Size 8½ by 13 inches; One Copy made out on White Stock

Form 1217

Mr. W. Williams Clock No. D-2360 Dept. No. D-31

To avoid making a charge against you, please settle your account in TOOL SUPPLY ROOM No. 1 on the following articles.

This notice will expire April 16, 1916

Signed Chas. Ninder

Date April 8, 1916 Dept. No. D-31

Fig. 18. Form used by Tool Supply Room in calling upon Workmen for Settlement of Tool Accounts; Size 5½ by 3 Inches; One Copy made out on Pink Stock

certain classes of special tool work, and for handling such work it is occasionally found necessary to lend tools for doing the work to these outside firms. Of course it is necessary to keep a record of tools which have been sent out this way, and such a record is maintained by issuing the form shown in Fig. 20. It will be seen that the upper part of the card is provided with spaces for the date and for the complete name and address of the firm to which the tools are to be shipped. The lower part of the form has spaces for descriptions of the tools; for the number to be shipped; and for the price, total value and classification of each kind of tool. After making out the order, it is checked by an inspector to see that everything is correct, after which the form is sent to the head of the maintenance supplies and tool service department for signature. The form is made out in triplicate, the first copy being sent to the manufacturing sales department, which looks after despatching the tools to their destination and rendering invoice, the second copy is held in the maintenance supplies and tool service department until the tools are returned, and the third copy is sent to the firm that does the work. If the tools are O. K. when returned, they are put in stock and credit is given to the firm who returns them.

The Repair of Commercial Tools

It will be recalled that when a workman damages a tool or wears it down so that he considers its use is no longer feasible, he takes the tool to his foreman and gets him to sign a tool release slip for it, which he turns in to the tool supply room with the tool in order to get his tool check or a new tool as the case may be. It will also be remembered that at the end of each week these tools are gone over by the inspector and the foreman of the tool supply room, to decide whether or not they have been worn down so that they are no longer fit for service. It may happen that some of these tools will be considered capable of giving an additional amount of service after certain repairs have been made on them, and such tools, together with the tools that have been slightly damaged in the shops, are sent to the tool-room to be put back into condition for future service. The making of such repairs involves keeping a record for several purposes. In the first place, the tool supply room must know what tools have been sent out and when these tools should be returned; care must be taken to see that all tools sent out for repairs are finally returned; and it is also necessary to give the tool-room instructions as to the nature of the repair that is required, and to keep a record of the cost of the work. For this purpose the form shown in Fig. 21 is employed. It will be seen that there is a notation "Charge Time and Material to Order No. 63920," which is a blanket order number that is applied on all jobs involving the repair of commercial tools against the department which uses the tools.

Five copies of this form are made out, the uses of which are as follows: The first copy is sent to the maintenance supplies and tool service department with the work, where it is filed by the department order number. The second copy also accompanies the work and goes on to the tool-room, where it is filed as a record of the work which the tool-room did on this particular job. The third copy accompanies the work as far as the office, where it is held during the time that the

REPLACEMENT FOR USE IN DEPT. D-23 ONLY									
T. S. R. 6		WEEK ENDING April 6, 1916		PAY PERIOD ENDING April 4, 1916					
DEPT. M-44									
ARTICLE	QUANTITY	SIZE	ARTICLE	QUANTITY	SIZE	ARTICLE	QUANTITY	SIZE	ARTICLE
18	6	0 180	Lead. Std. Tap	6	5/16 x 18	Lead. Std. Tap	6	5/16 x 18	Lead. Std. Tap
70	12	0 140	Std. H. S. Drill	12	1/4"	Std. H. S. Drill	12	1/4"	Std. H. S. Drill
12	4	0 28	Lead. Hand Taper	4	3/8"	Lead. Hand Taper	4	3/8"	Lead. Hand Taper
18	8	0 40	H. S. Std. End Mill	8	1 1/2 x 9	H. S. Std. End Mill	8	1 1/2 x 9	H. S. Std. End Mill
OK L. L. Nashins									
POSTED BY A. C. Carriere									
SIGNED D. B. McAdam									
J. P. Graham									

Fig. 19. Form used by Tool Salvage Department of Central Stock-room in making an Alphabetical List of Broken or Worn Tools; Size 8 1/2 by 7 1/4 inches; (Where a large number of Tools have to be recorded, the size of form is 8 1/2 by 13 inches); Three Copies made out on White, Yellow and White Stock

job is in the tool-room; it simply serves as a reminder to the office that this work is being done and must be looked after to see that it is put through with the customary dispatch. The fourth copy is a receipt that is given to the tool supply room for the tools which they have sent out to be repaired; this copy is sent with the work to be signed by the transfer clerk in the maintenance supplies and tool service department, and is then sent back to the tool supply room, where it is filed until the article has been returned. The fifth copy, which is merely a memorandum of the transaction held by the tool supply room, is destroyed as soon as the receipt is returned.

Twice a month a report is sent to the office of the maintenance supplies and tool service department showing the condition of each tool supply room as regards tools which have been sent out to be repaired, the form shown in Fig. 22 being used. It will be seen that the top of this form is similar to the one shown in Fig. 11, while the lower space provides columns for a complete description of the tools in question, the number which were sent out to be repaired, and the date of the receipt card for the tools which was sent down to the tool supply room at the time they were received in the tool-room. This report constitutes a check on the work of the tool-room in making repairs, and the distinction between its function and that of the weekly reports of the records kept by the tool supply room foreman should be carefully noticed.

In conjunction with a discussion of the question of handling worn out and damaged tools, the following description of the method of dealing with files is particularly important, owing to the rapidity with which this type of tool is used up. As in the case of other classes of commercial tools which are worn out, any workman in the shop who finds that his file has been worn down so that it will no longer give efficient service is required to take the file to the foreman of his department and get an order for the exchange of the worn out one for a new one. For this purpose use is made of the form shown in Fig. 23, which specifies the number, size and type of file which is to be given to the bearer; use is also made of this form when

the man has occasion to draw out a new file from the tool supply room.

Buying Tools for Employees

Every manufacturer recognizes that it is good policy to encourage employees to provide themselves with a good set of tools. The Cadillac Motor Car Co. makes a practice of purchasing any tools which employees want in order that the men may get advantage of the company's wholesale rates from tool manufacturers with whom it has regular dealings. The cost of these tools is deducted from the workman's pay, and for making this adjustment use is made of the form shown in Fig. 24. It will be seen that the form has spaces for the plant number in which the man is employed, the date, and the name and time-clock number of the employee. Below are noted the tools which he has purchased and the price. The form is made out in triplicate; the first copy is sent to the timekeeper for deducting the proper amount from the employee's pay; the second copy is sent to the employee in order that he may check up the deduction; the third copy is filed by the maintenance supplies and tool service department as a record of the tools purchased for the account of employees.

Sets of Tools for Special Operations

For certain operations which call for the use of a number of tools, it is the practice to have the complete set of tools packed in a numbered box, and when a workman is assigned to such an operation he goes to the tool supply room and hands in a single tool check for a complete box of tools. The purpose of this plan is to avoid requiring a workman to give up a large number of checks so that he would be left with an insufficient quantity for obtaining other tools that he might require. On the inside of these boxes there is a list which shows the complete outfit of tools, and records of such sets are maintained on cards of the form shown in Fig. 25. One side of this card gives a list of special tools such as jigs, fixtures, boring-bars, etc.; and the other side of the card gives a list of the standard commercial tools such as drills, reamers and counterbores. When these sets of tools are not in use, the boxes are put away in racks provided for that purpose, and in order to avoid having

a large number of commercial tools tied up in this way, such tools are removed from the boxes and added at the time that the set of tools is called for. This is easily done by the attendant in the tool supply room, who has merely to refer to

DEPT. 43-H.—COMMERCIAL TOOL SUB-DIVISION									
ISSUE SHIPPING ORDER—YES—NO					DATE April 5th, 1916				
Ship and Charge to J. N. Warner									
City Detroit Mich.									
Street and No. 18 Forsythe Ave.									
TOOL NAME	SIZE	QUANTITY	PRICE EACH	AMOUNT	CLASSIFICATION	REMARKS			
Lead. Std. Tap	5/16 x 18	2			58	Dept. 43-H			
Checked by L. L. Nashins									
SIGNED D. B. McAdam									
ORIGINAL PART'S SERVICE DEPT. COPY									

Fig. 20. Form used in authorizing Shipment of Tools for Use on Work done Outside Factory; Size 7 3/4 by 6 inches; Three Copies made out on Drab, Yellow and Blue Stock

T. S. R. Commercial Tool Repair Order			
Charge Time and Material			
To Order No. 63920	Date April 6, 1916		
From T. S. R. No. 6	To Dept. No. D. 28		
Amount	Name Jack Saw frame		
Remarks: Supply new handle			
H. G. Winters T. S. R. FOREMAN		Transfer Clerk R. M. Bacon	
Used in Dept. No. M-44		Per F. Irving	
FILE RECORD COPY			

Fig. 21. Form used by Tool Supply Room in ordering Repair of Commercial Tools; Size 8 1/2 by 3 1/2 inches; Five Copies made out on White, Blue, Drab, Yellow and Pink Stock

TOOL SUPPLY ROOM No. 4 Form 1453

Semi-monthly Report of Commercial Tools on Repair for two weeks ending April 14, 1916

Signed Chas. Ninder

Order No.	Date of Receipt Card	Amount	Size	Name of Tool
63940	Mar. 30, 1916	2	1/8"	Hand Expansion Reamer
64100	April 3, 1916	3	1/30"	Bul's Seal Indicator
64106	April 2, 1916	4	3/4"	Pipe Reamer

Fig. 22. Form used by T. S. E. Foreman in recording Progress made with Repair Work on Commercial Tools; Size 8 1/4 by 5 1/4 Inches; One Copy made out on Pink Stock

the label on the box which gives the list of commercial tools required, together with the size of the tools.

An important factor in the purchasing of maintenance supplies is the placing of orders at such a time that advantage may be taken of the best possible price. In order to do this, it is necessary for the head of the department to keep closely in touch with the purchasing department on both present market conditions and the probable trend of the market. Should he see that the price of some commodity for which his plant has constant use is likely to advance, he will proceed to lay in a sufficient supply to last through the period during which producers may ask unusually high prices.

Another important feature is the ordering of the exact class of material best suited for the purpose to which it is put, and the examination of the material when received to be sure that it accurately fulfills specifications. To assist in this work the company maintains a fully equipped laboratory in which chemical and physical tests may be conducted to determine the nature of all supplies that are likely to be adulterated. The experience of these chemists has taught them to know just about what adulterants to look for, and in many cases some surprising results have been obtained. For instance, one would hardly expect that the services of a chemist would prove of any great assistance in the purchase of sponges, but experience has proved the contrary to be the case. Sponges are bought at a specified price per pound, and tests conducted on sponges which failed to give satisfactory service revealed the fact that they had been loaded with glucose; as a result the weight indicated that a durable commodity was being obtained, but when the sponges were dipped in water it resulted in washing away the glucose and leaving a flimsy structure that had little durability.

The accurate work of the chemical laboratory may be taken as typical of the entire service rendered by the maintenance supplies and tool service department. In its operation nothing is left to chance; methods have been devised which are the last word in accuracy, and the records of each transaction

ORDER FOR FILES Form 1308

DEPT. No. M-67 DATE April 4, 1916

TOOL SUPPLY ROOM No. 2

DELIVER TO BEARER CLOCK No. M-6740

AMOUNT	SIZE	KIND	NUMBER	LETTER
1	6"	Flat Mill File	60	

SIGNED Geo. Elsey

Fig. 23. Form used by Foremen in authorizing Tool Supply Room to exchange Files for Workman; Size 5 1/2 by 3 1/4 Inches; One Copy made out on Drab Stock

which are kept, aided by the multiple checks which are applied to be sure that the records are accurate, make the occurrence of errors a matter of extreme improbability. That the benefits resulting from the use of this system have paid many times over for the cost incident to its operation is shown by the reduction in expenditures for tools and maintenance supplies which is revealed by a comparison of inventories over a period of years.

* * *

DEFECTIVE AUTO APPLIANCES

American manufacturers excel in developing special appliances and methods of manufacturing, but unfortunately not all have the reputation of producing goods that are reliable. The automobile accessory business has grown tremendously during the past ten years and is now an important industry in itself, aside from the manufacture of motor cars. In the race to produce accessories cheap and insure a large profit, the strength of some of the tools furnished has been reduced to the danger point, the result being some deplorable accidents. For example, an automobilist recently was crushed beneath his car which he had jacked up in order to repair it on the road. The jack broke while he was under the car and the weight of the car fractured several ribs and caused serious internal injuries. If such accidents become numerous, it will be necessary for the legislatures of the states to make laws providing that all accessories, like jacks, which might endanger the lives of the users shall be subjected to inspection before being sold and used. Such a condition is a serious reflection on the intelligence and honesty of manufacturers. Any manufacturer putting forth a product which seriously endangers the life and limbs of the users under normal conditions is a dangerous member of society.

* * *

Make up your mind to know all there is to know about your job, and by the time you do, there is likely to be a better one waiting for you.

TIMEKEEPER Form 1308

PLANT No. 1 DATE April 6, 1916

DEDUCT FROM WAGES OF

NAME Arthur Engel CLOCK NO. D-2370

AMT.	ARTICLE	PRICE	P. T. C. NO.	REQ. T. NO.
1	#8-1" B & S Micrometer	\$4.10		F-36170
1	#32.0 Starrett 6" Rule	.45		F-36171

TOTAL CHARGE \$4.55

CREDIT TOTAL AMOUNT OF P. T. C. =

AMOUNT TO DEDUCT \$4.55

SIGNED D. B. McAdam

TOOL INSPECTOR C. M. C. CO.

PER D. M.

No 6376

Fig. 24. Form used to charge Employees for Tools purchased for them; Size 6 by 4 inches; Three Copies made out on White, Pink and Blue Stock

COMMERCIAL TOOLS Form 1308

Quantity	Size	Description
6	3/8"	Taper Shank High Speed Drills
6	#2 to 2	Magic Collets
6	#2 to 2	Magic Chucks

Fig. 25. Form of Card used for recording Commercial Tools required in Sets for Special Purposes; Size 6 by 9 inches; One Copy made out on White Stock

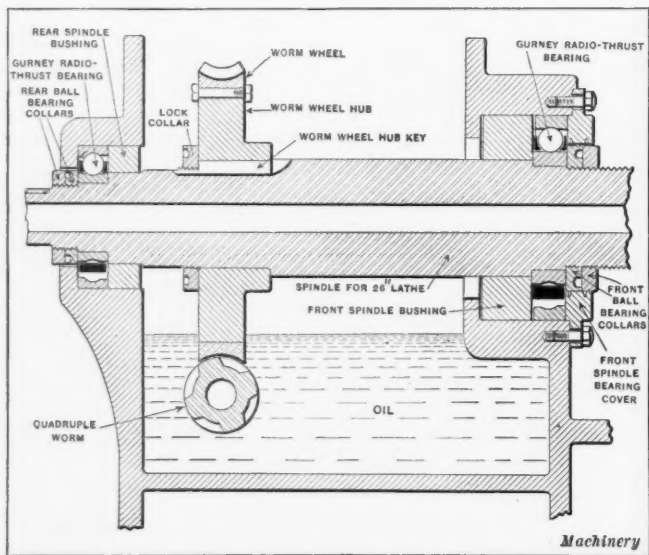
HART-PARR BALL-BEARING LATHE HEADSTOCK

The accompanying illustration shows a longitudinal section taken through the ball-bearing spindle of a projectile lathe built by the Hart-Parr Co., Charles City, Iowa. The lathe was illustrated and described in the May number, but these details of the headstock were not furnished in time to be used with the description.

The spindle is worm-driven, the worm being of the quadruple type, running in a bath of oil. A reservoir is provided in the headstock which holds from five to six gallons of oil, and the circulation induced by the worm and worm-wheel dissipates the heat through the oil and thence to the machine and the atmosphere. The spindle is mounted in Gurney radio-thrust bearings of the single-row annular type made by the Gurney Ball Bearing Co., Jamestown, N. Y.

The front end bearing next to the work is a Gurney 334 RT, having a bore of 6.693 inches, an outside diameter of 13.386 inches, a width of 2.244 inches, and fifteen $1\frac{1}{2}$ -inch balls. The rear bearing is a Gurney 322 RT, having a bore of 4.331 inches, an outside diameter of 9.449 inches, a width of 1.968 inch, and fourteen $1\frac{1}{2}$ -inch balls. These two bearings take both the radial and thrust loads in each direction, there being no other thrust bearing or thrust collar on the spindle. The mounting of these bearings on the spindle is simple; the spindle may be taken out by removing the two end plates that are bolted on. An important feature of these radial thrust bearings is that they are set up tight, there being no radial freedom whatever. This, of course, is quite different from the customary practice of setting up spindles in babbitt or bronze bearings. In plain bearings, sufficient radial freedom must be provided to allow for a film of lubricant between the spindle and the bearing.

It is claimed by some mechanical engineers that ball bearings when used on lathe spindles mark the work with annular waves, these being caused by the passage of the balls along the raceways in relation to the tool point. Some have gone so far as to suggest the use of a large number of small balls in order to reduce the distance between the balls to a minimum. But this expedient is unnecessary, as a properly constructed and designed ball bearing of sufficient capacity to carry the loads imposed on it will run perfectly smoothly when applied



Longitudinal Section through Spindle of Hart-Parr Ball-bearing Lathe Headstock

to a lathe spindle. In the case of the Hart-Parr lathe, it is claimed that the finish is so smooth that it is not necessary to grind the shells afterward.

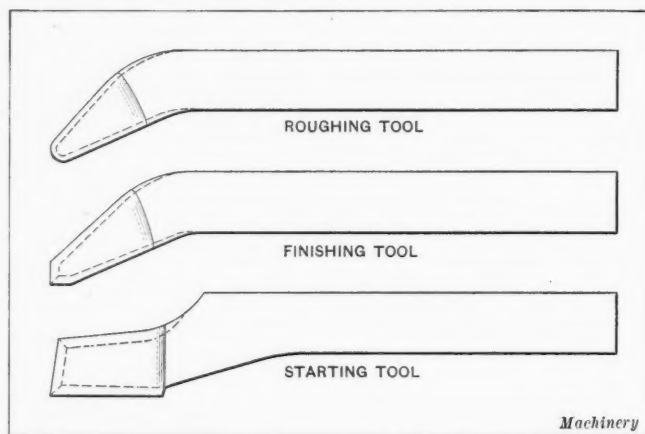
It is stated by the lathe maker that the spindle drives the heaviest cut without chatter. Repeated tests have been made on steel projectiles mounted on a mandrel screwed to the spindle nose, and without tailstock support, which have demonstrated that the combination of worm drive, heavy construction and anti-friction spindle bearings make remarkable production results possible. Cuts one-half inch deep with one-

sixteenth inch feed in 0.50 per cent carbon steel were taken without chatter at a distance of 36 inches from the front bearing. A plain spindle subjected to such a test would doubtless have chattered, because the projected area of a plain bearing would not have been sufficient to prevent the oil film from being broken down and displaced. The metal-to-metal contact of the spindle and bearing under heavy pressure would cause excessive friction and chatter. This cause of chatter in machine tools is often unsuspected, the fault being laid to other constructive features.

* * *

WOODEN FORMS FOR FORGED TOOLS

It is much easier to whittle the shape of a forged tool out of a piece of wood with a jack-knife or chisel than it is to forge the same thing in a hand forge. However, a wooden tool would be less likely to work satisfactorily on some of the present-day alloy steels, and therefore could not be used for this purpose. Some years ago, however, the writer saw a group of



Wooden Forms for Forged Tools

tools in which the cutting portion which would ordinarily be ground was painted with aluminum paint and the shank of the tool which goes in the tool-holder was black. These tools were in the office of the foreman of a boring mill department in a large factory and excited the writer's curiosity to some extent.

It was found that in the development of the machines for certain classes of work, the tools did not work quite as satisfactorily as was desired, due to more or less variation in the forms which were forged by the blacksmith. A set of these wooden tools was therefore whittled out carefully and given the desired shapes in all cases. These were then mounted on a board and sent out to the blacksmith shop and used for reference when forging up tools of the required shapes, so that the offset angles and rakes were the same in all cases. It was a very easy matter for the blacksmith to set an angular gage on the wooden form and repeat the same thing in the steel as he was forging it. It was found that after this group of wooden tools had been installed in the blacksmith shop, the tools produced were much more uniform and could be depended upon to do the work as required.

A. A. D.

* * *

MOUNTING GRINDING WHEELS

When a grinding wheel is brought to a machine for mounting, it should be inspected by some responsible person to see that the dimensions of the wheel—the diameter, thickness, hole, and if a cup or special wheel, the other measurements—are correct. Then the wheel should be sounded, that is, tapped lightly with a hammer to insure that it has not been cracked in transportation or handling. Special care is required to make sure that the speed of revolution is such that the surface speed of the grinding wheel is within the limit designated on the wheel tag. This is highly important, not alone because of the element of safety, but also because it is necessary for efficient production. At this time, too, the spindle should be looked over to make sure that there is no end play or looseness in the boxes. Vibration lowers production, increases wheel cost and tires the operator.—Grits and Grinds.

NEW METHOD OF BUILDING LATHES

BUILDING HEAVY LATHES WITHOUT MACHINE WORK ON THE BED CASTING

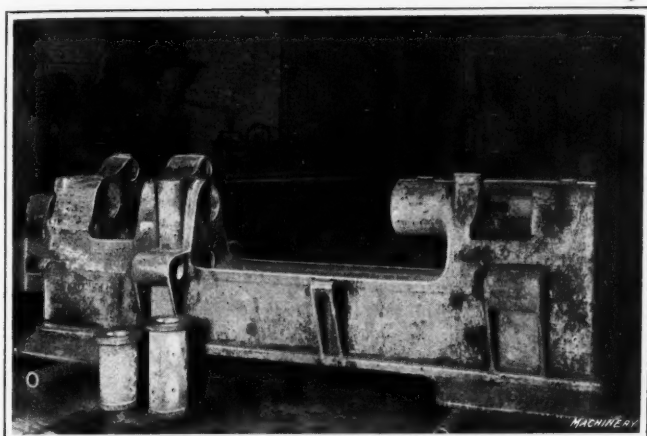


Fig. 1. Lathe-bed Casting ready to have Bearings and Ways assembled in Place. Note Headstock Spindle Bearings standing on Floor

THE use of jigs and fixtures in manufacturing machine parts has grown rapidly during recent years. This has resulted in increasing the rate of production and accurately controlling dimensions so that machine parts in general are made practically interchangeable with little hand work. But in machine tool building it has always been considered necessary to do a considerable amount of machine work on the frame castings, followed by hand scraping and fitting of bearings and similar parts where perfect fits and absolute alignment are required. This, hand work takes much time and must be done by skilled mechanics; and at the present, when machine tool builders are overburdened with work and the supply of experienced men is far below the demand, these hand finishing operations are among the factors which seriously limit the output of machinery factories.

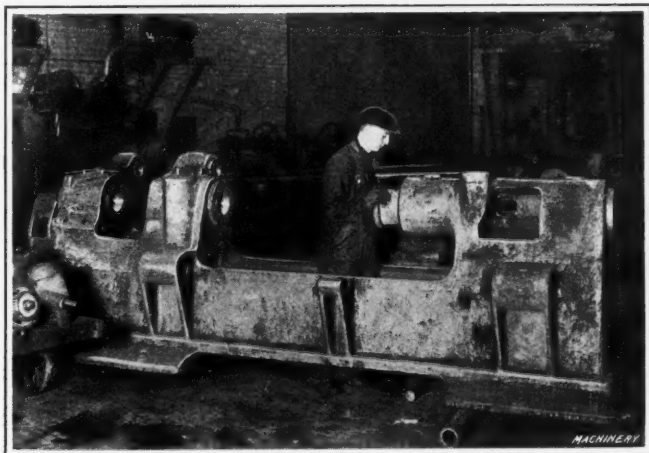


Fig. 2. Bed Casting with All Spindle and Shaft Bearings in Place. Note Truck Load of Parts at Left-hand Side of Machine

It is a matter of general knowledge that where castings are machined, the removal of the outer scale from certain sections of the casting allows the shrinkage strains in the metal to spring the casting out of shape. To overcome trouble from this source, the common practice is to take a cut over the surfaces to be machined and then set the casting aside for a sufficient length of time for it to become fully "seasoned" before the final machining operations are performed. Not only does such a method of procedure call for the expenditure of time and labor in machining, but it requires the castings to be held in the factory for a considerable period of time before they can be put into a finished machine. This is a severe drawback under conditions such as those which exist at the present time, when machinery builders are doing their utmost to secure the maximum production in their shops.

With the view of overcoming these difficulties, the Amalgamated Machinery Corporation, 72 W. Adams St., Chicago,

Ill., has developed a method of lathe-bed construction, upon which patents have been granted, that virtually eliminates all machining and fitting operations, absolutely no machine work being done on the lathe beds. This result is obtained by the employment of turned and ground steel rods for the ways and cross-slides, that are supported in brackets provided on the bed and saddle castings. These rods are made of turned and ground 50 point carbon steel, and are sold under a guarantee that the error in alignment does not exceed 0.0005 inch in a length of eight feet. The headstock and tailstock are cast integral with the bed, and all spindle and shaft bearings are carried by iron bushings which are set in place in cored holes in the castings.

It will be evident that for such a construction to give satisfactory results, means must be provided for obtaining abso-

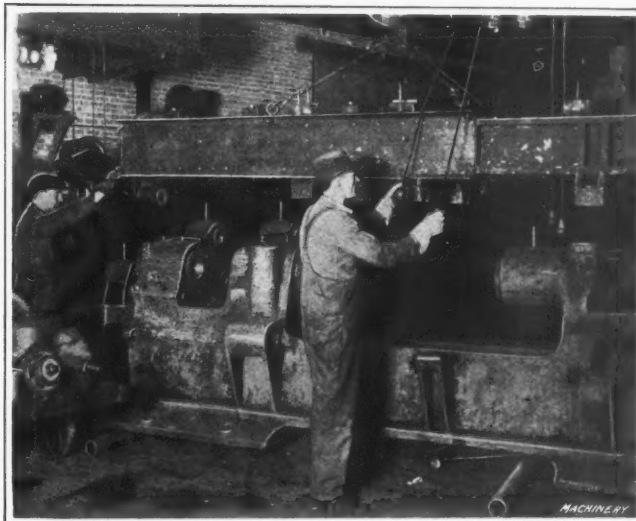


Fig. 3. Lowering Assembling Jig into Place on Casting. Note Bearings on Under Side of Jig for bringing Lathe Bearings and Ways into Alignment

lutely accurate alignment of all working parts, and this is done by means of an assembling jig which is dropped in place over the bed casting. This jig has brackets which fit snugly over the steel rods that form the ways, and close fitting bearings for mandrels that fit through the different spindle and shaft bearings. When all the machine members have been lined up in this way, a low melting alloy is poured into the annular spaces between the cored holes in the lathe-bed casting, and the machine members are held in these holes, so that when the molten metal has solidified, all parts are secured in

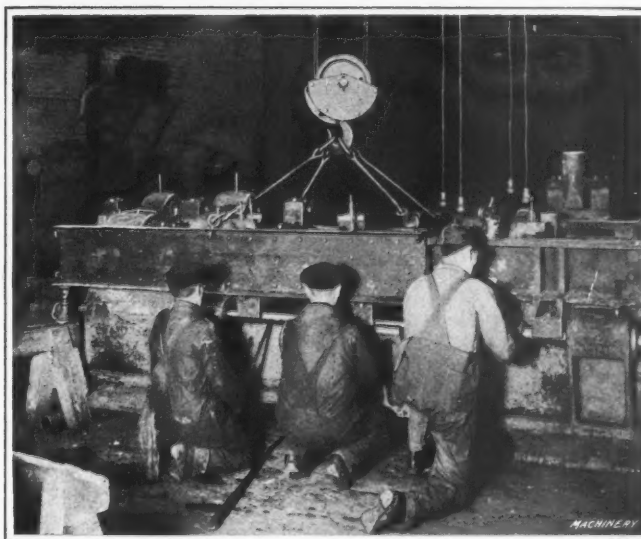


Fig. 4. Putting One of the Hardened and Ground Steel Rods into Brackets on Casting. Notice Method of Location from Bearings on Jig

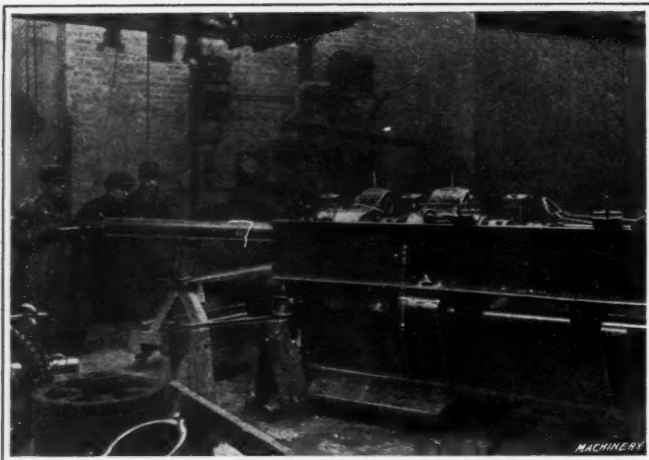


Fig. 5. Pushing in Mandrel which locates Spindle Bearings in Alignment with each other and with Ways on Lathe Bed

exactly the required positions. With this brief statement in regard to the general features of the type of construction, we are in a position to proceed with a detailed description of the method of assembling.

Arrangement of the Assembling Department

In the factory of the Amalgamated Machinery Corporation, the erecting department occupies bays which are of the required width to enable the machines to be placed crosswise and leave sufficient room to handle the work advantageously. Each bay is provided with a special form of overhead revolving jib crane; and at each assembling station in the bay two jib cranes are available for handling parts that are too heavy to be readily moved by hand. The bed castings are distributed on the floor, one to each space, and a complete set of parts to be assembled on a machine are brought to each station on trucks so that all the pieces are available for instant use.

In this connection it should be mentioned that the cast-iron bushings which carry the head spindle are babbitted ready for use at the time they come to the assembling floor. It is a well-known fact that the composition of babbitt metal is changed each time it is melted, as a result of the reduction in percentage of certain constituents through oxidation. This affects the physical properties of the babbitt and in cases where the metal is remelted a number of times, its character may have so seriously deteriorated that it will no longer be capable of giving satisfactory service. In the babbitted spindle bearings used by the Amalgamated Machinery Corporation, this trouble has been effectually overcome by sending the cast-iron bushings out to be babbitted by the company which makes the babbitt metal. The practice followed is to line the bearings at the time that the babbitt metal is first compounded, so that it is poured into the bushings at once and there is no danger of securing metal of an inferior quality as the result

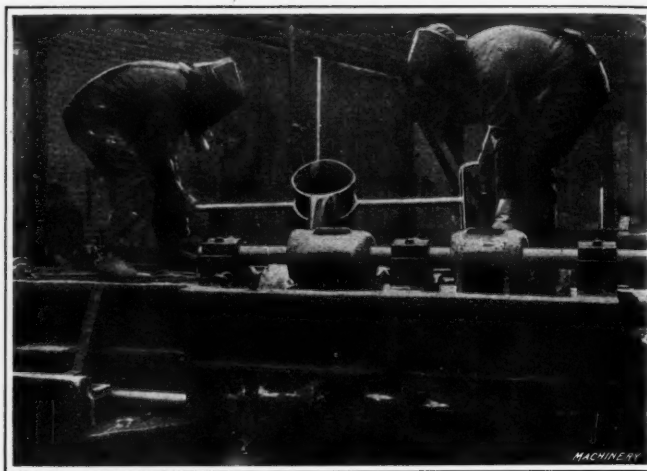


Fig. 6. Pouring Clamping Metal. Attention is called to Arrangement of Clay to hold Molten Metal in Place until it solidifies

of deterioration due to the removal of certain constituents by oxidation.

Assembling the Lathe Bed

Reference has already been made to the fact that the bed casting has the headstock and tailstock cast integral with it; and one-piece bearings are employed for both the head and tail spindles. Fig. 1 shows one of the finished lathe-bed castings with the two headstock spindle bearings standing beside it; and in Fig. 2 the bearing bushings have been pushed into the spindle and shaft holes in the headstock, and a man is shown pushing one of the bearings into place in the tailstock. After this part of the work has been done, the assembling jig is lowered into place over the bed casting, as shown in Fig. 3, after which the turned and ground steel rods that form the ways are pushed into place in the bracket holes at the front and back of the casting. The assembling jig is provided with bearings which are carefully machined to fit around the steel bars that form the ways, so that they will be located in accurate alignment with each other; and similar bearings align mandrels which are a close fit in the spindle and shaft bearings in the lathe bed so that all bearings will be located parallel to each other and to the ways. These locating bearings can be seen on the under side of the jig in Fig. 3; Fig. 4 shows the jig in place on the lathe-bed casting; and in Fig. 5 one of the aligning mandrels is being pushed into place.

Pouring the Clamping Metal

After all the parts have been properly located in the cored holes in the lathe-bed casting, the assemblers are ready to pour in the molten metal which solidifies in the spaces between these parts and the bed casting to hold them in place. A brief consideration will make it evident that the metal which may be satisfactorily employed for this purpose must possess certain characteristics. In the first place, it must neither expand

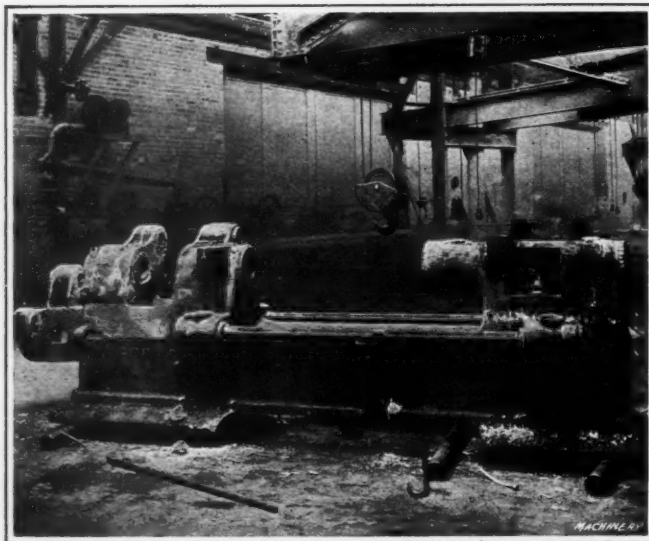


Fig. 7. Finished Lathe Bed as it appeared immediately after Removal of Assembling Jig

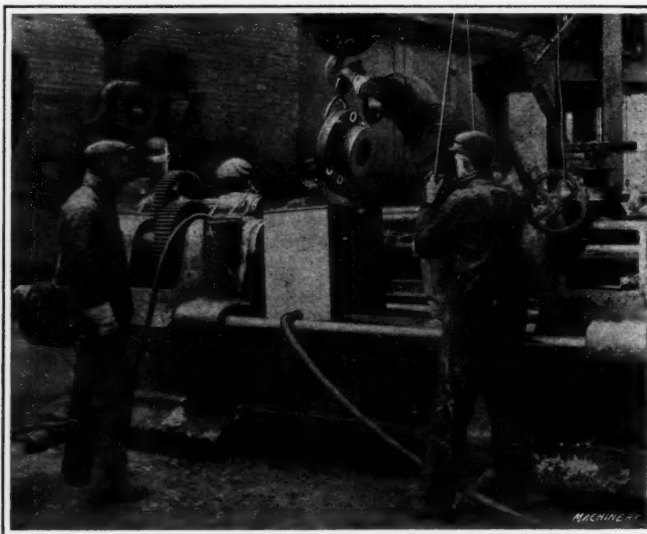


Fig. 8. Lowering Faceplate into Place ready to be heated and then shrunk onto Lathe Spindle

nor contract after being poured, as such a condition would result in either straining the casting or leaving the different machine members loose in their holes in the casting. The metal must also be of such a nature that it will not crystallize nor change its structure in any way as the result of vibration, and it must be tenacious enough to support adequately the load imposed upon it. The alloy used for this purpose was developed as a result of experimental work, and is a type metal of special composition. In order to take advantage of the peculiar properties of this metal, it must be poured at a certain specified temperature which was determined by experiment, as it has been found that a deviation of even 30 degrees above or below this temperature will result in expansion or contraction of the metal as it solidifies, which prevents obtaining satisfactory results.

To provide for accurately controlling the temperature of the metal, it is melted in pots heated with saturated steam, and an experienced metallurgist devotes all of his time to providing the assembling department with metal at exactly the required temperature. Melting pots are located at intervals down the side of the bays, and the ladles for pouring the metal are of different sizes which contain just the proper volume to fill the annular spaces without waste. The weight of each size of ladle has been carefully calculated, so that when the molten metal is poured into it from the melting pot, the ladle will

rods which are secured in place by the method which has just been described. Assembling jigs are provided for aligning the different members of the carriage preparatory to pouring the clamping metal. The work of assembling other parts of the machine is essentially the same as in any machine tool building establishment.

The Amalgamated Machinery Corporation makes four sizes of machines and four types of each size. In order to insure interchangeability, the assembling jigs for each size of machine are made from a master jig so that all dimensions are held constant. For example, on one size of machine there are seventeen assembling jigs in use, all of which are made from the master jig. This shows the importance of having a single standard which governs the dimensions of a given size of machine. The same thing is true of the jigs used for assembling both the carriages and lathe beds. The accuracy of alignment secured is shown by the fact that out of several thousand Amalgamated lathes which are in use, no trouble has been experienced from bearings running hot. Another interesting feature of the construction is the claim made that it is impossible to make one of these lathes vibrate in a way which will cause the tool to chatter. The explanation offered is that all important bearings float on a metal which tends to absorb vibration rather than transmit it from one machine member to another. Whether or not this is the correct expla-

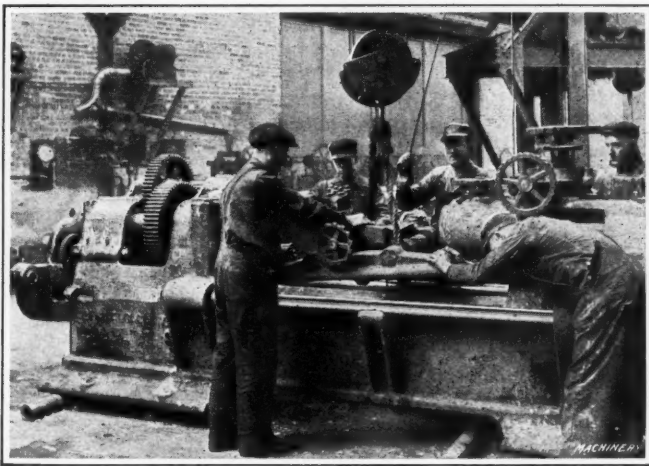


Fig. 9. Assembling Carriage onto Lathe Bed. Attention is called to Design of Carriage

absorb just enough heat to reduce the temperature of the metal from that of the melting pot, which is a little too high, to exactly the temperature at which it must be poured in order to avoid expansion or contraction while cooling.

It will be evident that means must be provided for retaining the metal in the space which it is desired to fill, and these means are provided by packing clay around each end of the annular space; a small cup of clay is also packed around the cored hole through which the metal is poured into the annular space to be filled. This clay is mixed and cut into ribbons, in which form it is sent to the assembling department, so it may be conveniently handled. After the clamping metal has been poured, it cools and solidifies almost instantly because of the large mass of iron surrounding each pocket. It is stated that this cooling action is so rapid that a person can hold his hand on the outside of the casting or the inside of a bearing at the time the clamping metal is poured without burning it. As a result, there is no danger of distorting the babbitt bearing liners. After sufficient time has been allowed for the molten metal to cool and solidify, the assembling jig is removed from the casting and the strips of retaining clay are scraped away. The workman then goes over the machine with a file and removes any protruding metal, but he does not attempt to hammer down the metal, as this would result in introducing strains and possibly changing the structure.

Assembling the Lathe Carriage

The lathe carriage consists of two cast-iron shoes with grooves which fit over the ways on the bed. The cross-slide on the carriage is formed by two hardened and ground steel



Fig. 10. Finished Shell Lathe, and Gang of Four Men and Foreman who assembled it in Six and One-quarter Hours

nation, the fact remains that it is impossible to operate the lathe in a way which will produce noticeable chatter of the tool.

Other Possible Applications of This Method of Construction

Although this method of construction was developed for building shell lathes rapidly without the employment of a great amount of skilled labor, it appears to offer possibilities of application in the construction of a variety of other classes of machinery and engines. In manufacturing small machines, it should be possible to provide for forcing the molten metal into the casting under pressure in much the same way that die-castings are made. This would insure obtaining a very dense metal, and would also enable the metal to be delivered from the melting pot the same as on die-casting machines. An idea of the rapidity with which the work of assembling can be done will be gathered from the fact that in the case of large lathes weighing approximately 20,000 pounds, the entire assembling operation can be completed by a gang of four men in 7½ hours; such a gang of men assembles two complete lathes a day. Obviously such an achievement would be out of the question, were it necessary to employ hand work for scraping the bearings and ways to an accurate fit. E. K. H.

During the past five years, the average pay of the employees of one large manufacturing concern in Detroit, Mich., has increased 32 per cent. The wages of high-class mechanics, including toolmakers, die-makers, and first-rate machinists, have increased as much as 80 per cent. This rapid rise in wages in Detroit has been partly due to the competition of the motor car manufacturers.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Manufacturer Cannot Waive Agent's Warranty

(Oklahoma) The Oklahoma Supreme Court has held in the case of the *International Harvester Co. v. Lawyer* that the manufacturer of machinery may be held on its oral warranty, though the purchaser of the machinery later, at the request of the manufacturer, signed an order which expressly provided that the machinery was sold without warranty.

The facts of the case were that the plaintiff, Lawyer, purchased machinery from an agent of the International Harvester Co. in Oklahoma. The agent, in making the sale, warranted the machinery to be free from defects. He secured his authorization in making this warranty from the agency contract which existed between himself and the International Harvester Co. On delivering the machinery, the International Harvester Co. sent the purchaser a form of order containing a clause to the effect that the machinery sold was not warranted in any way. The machinery was found to be defective and plaintiff notified the agent, who, in turn, called the matter to the attention of the company and asked for an adjustment. The International Harvester Co. refused to adjust the matter, setting forth the stipulation as contained in the printed order. Suit resulted and the Supreme Court of Oklahoma on appeal held that the International Harvester Co. was liable for the warranty as made by its agent, and that the written order in no way relieved the company of its obligation to make good any defects in the machinery. The court said that the agent by authority of his agency agreement with the company had a right to warrant the machinery, which warranty could in no way be discharged by an act of the International Harvester Co. itself. (*International Harvester Co. v. Lawyer*, 155 Pac. 618.)

Transfer of Machinery for Benefit of Creditors

(Iowa) In the case of *Stacy v. Brown-Hurley Co.*, Iowa Supreme Court, it has been held that a manufacturer who is badly in debt may transfer mortgaged machinery to one of his creditors as trustee, to manage and dispose of the same to the best advantage for the benefit of all creditors. The court further says that the trustee is not chargeable with bad faith though he induced a friend to take up the mortgages on the machinery and to hold the machinery with the expectation of realizing more than could be realized by a forced sale. An effort on the part of the trustee to secure to creditors as large a part of their claims as possible is considered commendable by the court. (*Stacy v. Brown-Hurley Co.*, 156 N. W. 695.)

May Refuse Payment of Purchase Note

(Oklahoma) Where a manufacturer of machinery in making a sale accepts the purchaser's promissory note as part payment for the machinery, the purchaser may refuse payment of the note if it is later found that the machinery does not meet the warranty as to its fitness to perform the work for which it was sold. (*Murray Co. v. Palmer*, 154 Pac. 1137.)

Damages to Boilermaker

(Federal) The United States District Court in the case of *In re the Anglo-Patagonian* has held that a riveter and boilermaker, forty years old, who has been employed for fifteen years and making from twenty to twenty-five dollars per week, is entitled to \$7000 damages for partial injuries received in the course of his employment. The injuries consisted of a fracture of the upper part of the arm, a broken ankle and partial paralysis of the right arm. (*The Anglo-Patagonian*, 228 Fed. 1014.)

Misdelivery of Machinery

(Massachusetts) Where neither the shipper of a crate containing machinery nor her agent, the expressman who delivered it to a steamship company for transportation, objected to the terms of a bill of lading which gave a different address for the consignee from that appearing on the crate, the steamship company could rely on the bill of lading issued as to the address and was not liable for delivery to the consignee

as indicated therein. (*Porter v. Oceanic S.S. Co.*, 111 N. E. 864.)

Operator of Crane Allowed Recovery

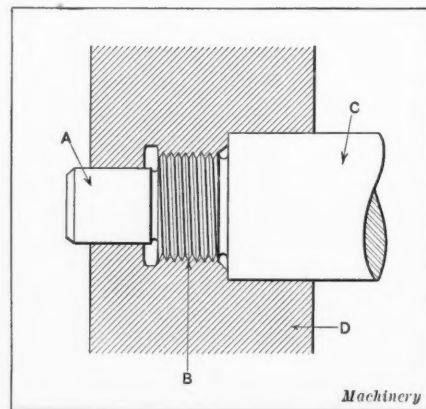
(New York) An interesting application of the Workmen's Compensation Law is found in *Rist v. Larkin & Sangster*, a New York Supreme Court case decided by Judge Kellogg on appeal by employers from an award of compensation to plaintiff. The facts show that the plaintiff was operating a crane on the Mohawk river, when the crane broke and he jumped into the river to avoid injury. He waded to shore, and as a result of that exposure contracted a heavy cold leading on to tuberculosis, and he has been disabled ever since. In part the decision reads: "We consider the claimant in the same position as if the accident had thrown him into the river, and, clearly, his being accidentally thrown ten feet into the water was an injury within the meaning of the act, and the disease following has been found to result naturally and unavoidably from that injury. He, at the time, was not physically disabled by jumping into the water, and it was not then quite clear what injury he had sustained, but it has developed that the injury was very serious." (*Rist v. Larkin & Sangster*, 156 N. Y. S. 875.)

* * *

CONCENTRICITY OF THREADED AND CYLINDRICAL WORK

When conditions in designing require the use of a construction similar to that shown in the accompanying illustration, difficulty is sometimes experienced in assembling on account of a lack of concentricity between the threaded part *B* and the plain cylindrical portions *A* and *C*. If the work is machined

on centers in a lathe, the various parts will be concentric, but when made up on a turret lathe or screw machine as required in quantity production, there are two chances for error in machining: first, in the work *D* the tap for the hole may run out of truth unless it is piloted; and second, the die which



Concentricity of Threaded and Cylindrical Work

is used to cut the thread of the screw *B* may not be started absolutely true with the other cylindrical surfaces, and may therefore cut a thread which is not concentric.

In order to obtain good commercial work of this kind, it is essential that the threaded portion be made a "free fit" in order to neutralize the variations caused by the running of the tap or die. The amount of freedom necessary depends on the diameter, pitch and the method of machining.

A. A. D.

* * *

RAILWAY RECORDS

Railway safety records were broken in 1916 when 325 American roads reported to the Bureau of Railway News and Statistics, in Chicago, that through the fiscal year to June 30, they had operated without a fatality to a passenger in a train accident. The roads reporting operate 161,948 miles of line. All American roads in 1915 operating over 250,000 miles of line reported 196 passengers killed in all railway accidents. In comparison, the latest report from Europe of 197,015 miles showed 700 passengers killed. This gratifying record of American railroads shows what has been accomplished by the "Safety First" movement. The movement is extending to every branch of industry and its effect will be to reduce the toll of useless killing and maiming and to make life and limb safer in all occupations.

SOME TOOLS USED IN MANUFACTURING THE CORONA TYPEWRITER

TOOLS AND DEVICES USED IN THE PRODUCTION OF A TYPEWRITER WEIGHING ONLY SIX POUNDS



Fig. 1. Corona Typewriter—opened up ready for Use

culties is evidenced by the reputation its machine is making, and the success is due, in a large measure, to its excellent manufacturing methods and tools, a few of which will be touched upon in this article. To appreciate the tools, it may be said that the Corona typewriter, which, in use, appears as shown in the illustration Fig. 1, folds into the compact size of 9 by 10½ by 4 inches, as shown in Fig. 2, and weighs but six pounds.

Dies for Blanking, Piercing and Forming Corona Typewriter Parts

Two of the dies for punching and partly forming the aluminum frame for the Corona typewriter comprise a most interesting set of tools; these are shown in Figs. 3, 4 and 5. The frame is made of aluminum, 0.162 inch thick, and before bending to the form of a square the frame blank is a little over thirty inches long. The blanking is done in an ordinary die that cuts the blank from strips that have been sheared to the right width for one frame, after which the frame goes to the die shown in Fig. 3 to have the forty holes pierced, and then

to the die illustrated in Figs. 4 and 5, which performs the first bending operation. The subsequent bending tools are so simple that they will not be described here.

The smallest of the forty holes in this frame is 0.076 inch diameter, which is quite small in comparison

with the 0.162 inch thick stock. In addition to piercing the holes, the scallops, one on each side of the center, are clipped and the ends of the frame trimmed to length at this time. Fig. 3 shows the construction of this sub-press die and reproduces a sample of the pierced work. The die is made throughout of "Ketos" steel, and there are five sections, each of which carries a number of the holes. The forty punches are so inserted in the punch-plate that they may be quickly removed in case of breakage. They are guided by long bushings that are mounted in the stripper-plate. In addition, the large sub-press pins at the ends maintain the alignment of the die.

An interesting feature of this die is the method of insuring that the blank is correctly positioned before the punches come into action. There are five spring fingers A on the punch-plate that press the blank back against the gages just before the piercing punches enter the work. These "crowders" insure that the blank does not slip from its position against the gages. The end-trimming punches are piloted in the die, by using guide-shoulders on the punches.



Fig. 2. Corona Typewriter—folded and ready for Case

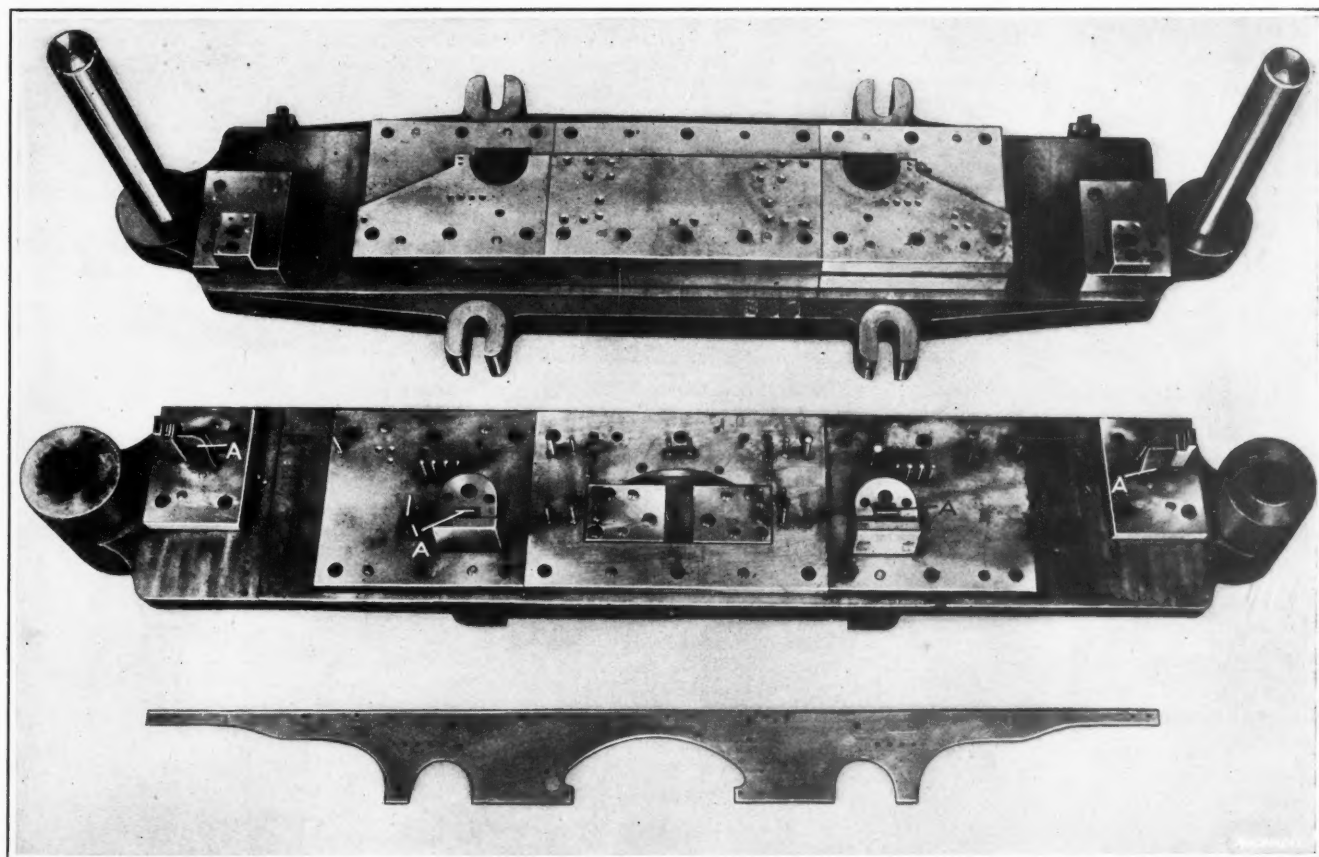


Fig. 3. Piercing Die for Typewriter Frame Strips

Figs. 4 and 5 illustrate the bending die that operates on the frame after it has been pierced. Fig. 4 shows the die and punch and the frame as it leaves the tools, and Fig. 5 illustrates the operation of the die. This shows the blank in position on the die and the bent frame on the punch in the position that it has taken after forming. Referring to the frame in Fig. 4, the bends made are the offsets *A*, the lugs *B* and the right-angle bends *C*. The center of the punch forms a long spring pad *D*. The frame blank is laid on the die, against

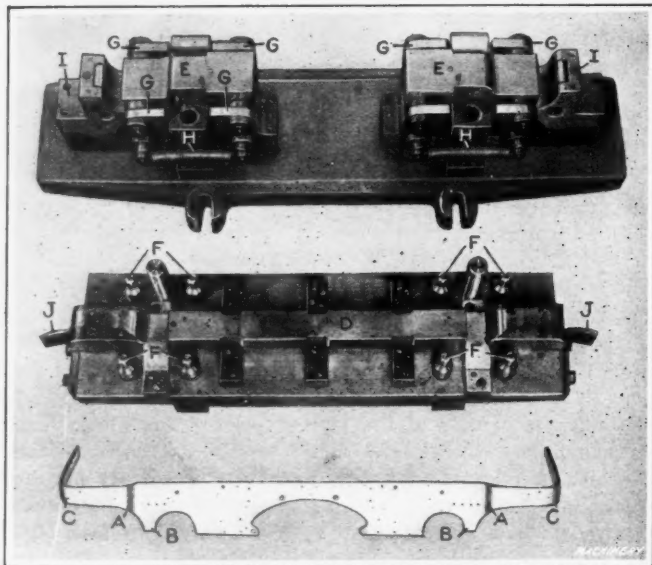


Fig. 4. Frame Bending Die and its Product

gages, one pair of which locates from the back and another pair engages holes to locate the blank endwise.

The first action of the die is to compress the spring pad *D*, thus gripping the punching firmly between it and the two die panels *E*, while the offset bends are being formed by the retreating spring pressure pad. The next action is brought about by the eight pins *F* that strike the short levers *G* in the die. These levers are really upper members of toggles upon which the die panels are supported. The toggles are kept normally straight by four spiral springs *H* that connect the middle joints

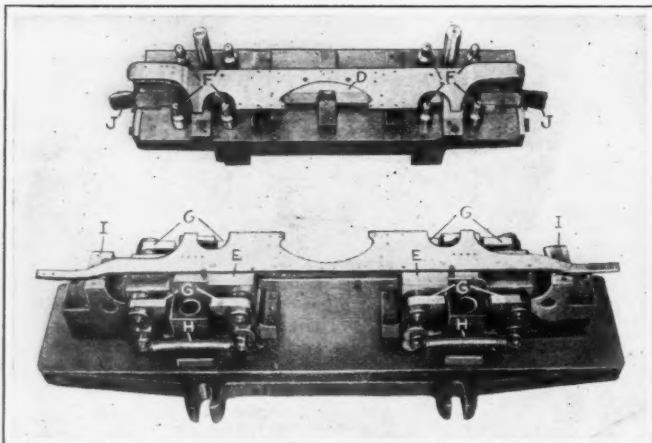


Fig. 5. Frame Bending Die, illustrating Operation

of each pair of opposed toggles. When levers *G* are depressed by the descending punches *F*, the toggles open, allowing the punch to carry the work and the die panels *E* down to the limit of the toggle opening. The ends of the frame are obstructed, however, in their downward path by form brackets *I* that bend them to a right angle. Rolls are inserted in these brackets to assist in bending the stock without marring. Lugs *J* prevent the frame ends from kicking forward when the bending operation is starting. At the time of making the offset bends, lugs *C* are also curled over. Two sub-press pins insure the die retaining its alignment. This die, while decidedly out of the ordinary in design, has worked out very successfully in practice.

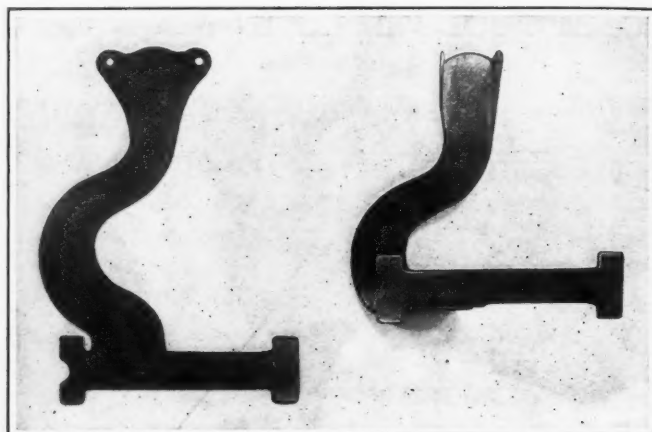


Fig. 6. Paper Finger Clip—before and after Bending

A complicated bending die for forming the paper finger clip shown in Fig. 6 is illustrated in Fig. 7. This die takes a blank punching, as shown at the left-hand side of Fig. 6, and bends it in one operation into the completed form shown at the right-hand side of the illustration. This clip is made from sheet steel, 0.018 inch thick. From Fig. 6 it will be seen that there is a compound bend to be made, consisting of turn-

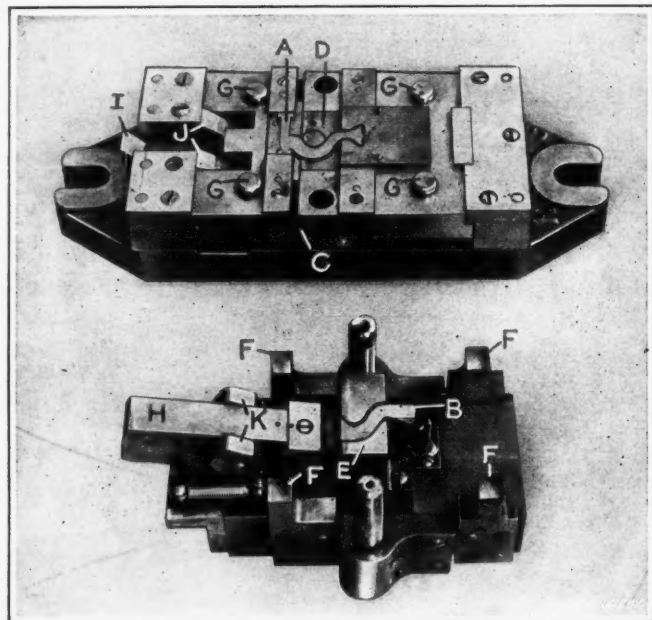


Fig. 7. Tools for bending Paper Clip

ing up the ears on one end of the clip, and making a double bend at the opposite end. On the die at *A* is one of the blanks ready to be bent, and on the punch at *B* is one of the completely bent pieces. The entire face of the die forms a pressure pad *C* that is supported on heavy spiral springs. At the center of the die is a smaller secondary pressure pad *D* supported

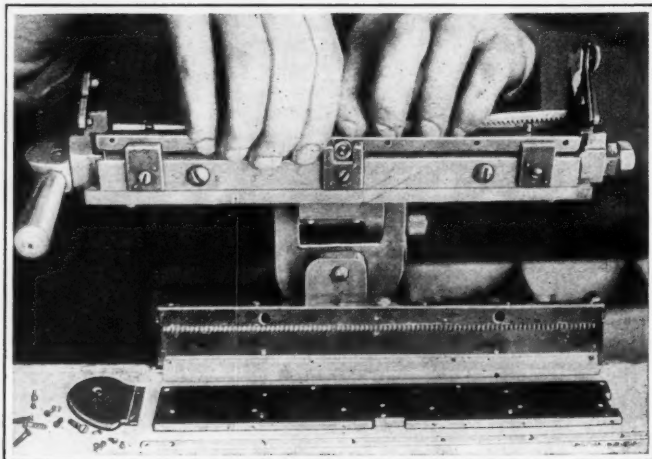


Fig. 8. Carriage Assembling—putting Parts on Under Side

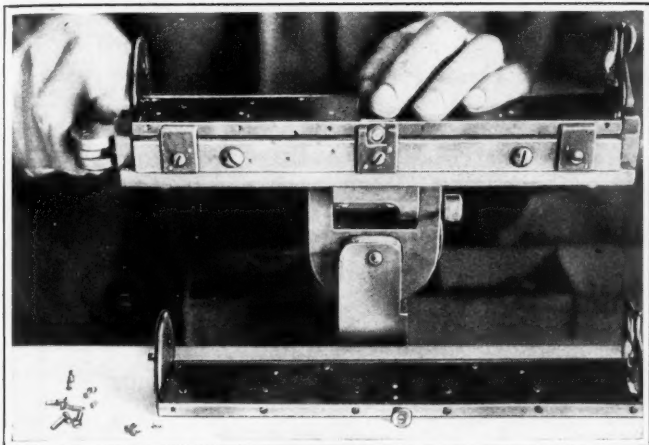


Fig. 9. Carriage Assembling—clamping End Plates

on much weaker springs than pad *C*. When the punch descends, the punch projection *E* forces the blank through the main pressure pad which acts as a solid die up to this point. In this manner the ears are thrown up and a right-angle bend is made at the wide end of the blank, as shown.

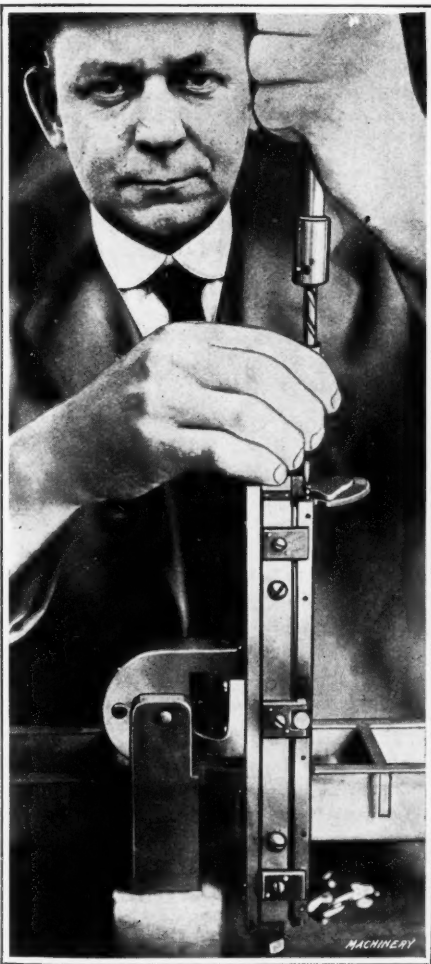


Fig. 10. Carriage Assembling—putting in End Plate Screws

opposite end of the lever against the blank, holding it close against the punch, while die surfaces *J* bear against toggle surfaces *K* and force the lever and hence the blank inward around the under-cut section of the punch, leaving it on the punch, as shown in this illustration. This completes the bending operation and the piece is slid from the gooseneck shaped punch and dropped out of the die.

Fixtures for Assembling Corona Carriages

In Figs. 8 to 10 is illustrated the use of a fixture for assembling Corona typewriter carriages. The work to be done consists of assembling the back rail, rack, ball race, paper finger rail and two carriage ends to the carriage back plate. To do this requires the insertion of twenty-six screws from five

different directions. Fig. 8 shows the beginning of the assembling operation, the fixture and some of the carriage parts. In the immediate foreground are some of the parts and directly behind is an assembled carriage. The various sizes of screws used are kept in a compartment box that may be seen just behind the fixture. The fixture may be used in the position shown, or it may be tipped 90 degrees to the right, left, front or back, by shifting the index pin at the center.

The first operation consists in loading the fixture with the parts that go on the under side of the carriage. These parts drop into respective grooves in the fixture. The first of these, which is shown being inserted in the foreground, is the carriage back rail. In the center is the rack, at the rear is the ball race, and on the further side is the paper finger rail, the two latter pieces being connected in Fig. 8. The carriage plate

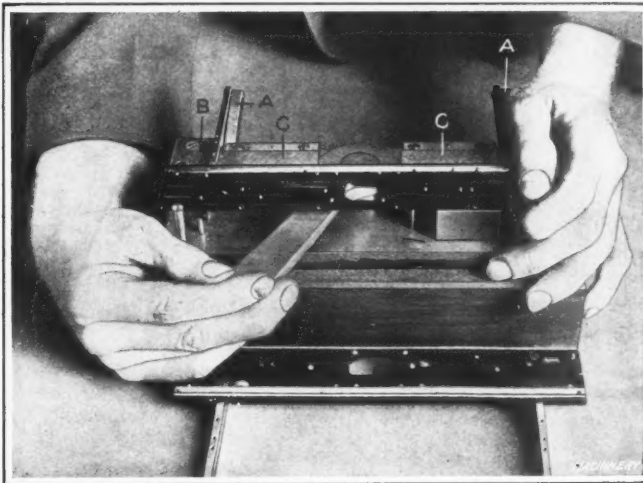


Fig. 11. Fixture for assembling Folding Arms to Carriage Bed Plate

is now slipped into place. Next, the end plates are located on pins in the guide brackets on the ends of the fixture.

Fig. 9 shows the clamping of the end plates in place, with the cam lever in the assembler's right hand. After this, the ten screws for attaching the rack and ball race are inserted, using a quick-acting screwdriver. The fixture is now thrown 90 degrees sidewise, bringing it into the position shown in Fig. 10, and the screws in the end plate are inserted. The fixture is then reversed 180 degrees and the opposite end plate screws are driven in, which completes the assembling operation.

The designing of this fixture was the result of efficiency studies on this particular operation, which previous to the installation of this fixture was a laborious operation, taking

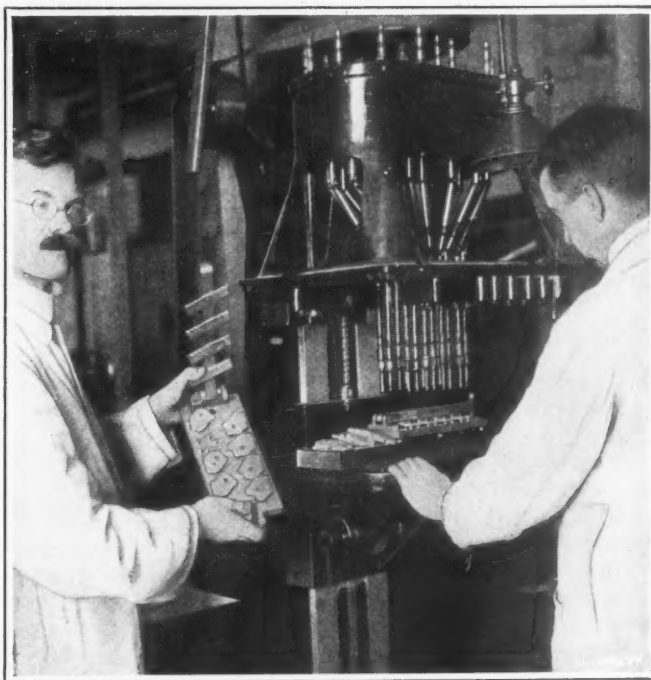


Fig. 12. Counterboring on a Multiple Spindle Drilling Machine

eighteen minutes. With this fixture in use, the operation is completed in less than five minutes.

The assembling of the two folding arms to the carriage bed plate was formerly a troublesome operation because of the difficulty of making them square with the bed plate. A fixture was made to facilitate this operation, and from Fig. 11 the method of operation may be easily followed. In front of the fixture one of the assembled carriage bed plates may be seen, and it will be noticed that each of the folding arms is attached with two screws. At the farther side of the fixture are two arms or gages carrying pins for locating the two arms to be attached. These arms are placed on pins on the gages A and are located at the sides by gage-blocks, one of which is shown at B. By throwing over the central cam lever, two jaws C are moved against the sides of the folding arms and grip them tightly while the four screws attaching the carriage bed plate are driven in. While the primary object in designing this fixture was to provide an assembling method that would produce the best work, its use increased production 100 per cent over hand assembling.

Fig. 12 shows a counterboring operation that is performed in an unusual way on a multiple drilling machine. The pieces are aluminum carriage ends, which are blanked from 3/16 inch stock and at the same time have two holes pierced in them. The operation to be performed is the counterboring of these two holes. A jig that holds eight pieces is used, and the work is done on a multiple spindle drilling machine, using sixteen spindles. Two men are employed on the job, one of whom loads a jig full of work while the machine operator is counterboring the work in a second jig. Handled in this manner, the machine is kept working all the time and the production is very rapid.

C. L. L.

CALCULATING CHANGE-GEARS FOR HOBGING SPIRAL GEARS

BY GEORGE ALLINGTON

The following method of calculating change-gears required for hobbing spiral gears on the No. 12 Barber-Colman gear-hobber, reduces what has formerly been regarded as a somewhat tedious problem into a direct process which gives extremely accurate results. The usual method is to substitute in Formula (1) a certain value for the feed which will cancel into the available change-gears for the indexing, and then substitute in Formula (2) the same value for the feed which must cancel into the available change-gears for the feed motion. The following method was developed with the view of eliminating slight errors in the gear ratios that it is usually necessary to employ in order that these cancellations may be made in Formulas (1) and (2). Any feed used in hobbing spur gears, that is suitable for the work, can also be used for spiral gears; and by employing Table II the proper index gears may be quickly determined without resorting to the method of cancellation. The following are the formulas referred to:

$$\text{For index gears: } \frac{30}{N \pm \frac{FS}{P}} = \frac{\text{drivers}}{\text{driven gears}} \quad (1)$$

$$\text{For feed gears: } \frac{F}{0.075} = \frac{\text{drivers}}{\text{driven gears}} \quad (2)$$

where N = number of teeth in gear to be cut;

F = desired feed;

S = sine of angle of spiral;

P = normal circular pitch = $\frac{3.1416}{\text{diametral pitch of hob}}$

The minus sign is used when the spiral gear and hob are both right-hand or both left-hand; and the plus sign is used when the spiral gear is right-hand and the hob left-hand or vice versa. The proper feed to use depends upon the nature of the work, the material and the angle of the spiral; and the larger the spiral angle, the smaller should be the feed per

revolution of the gear blank. Table I covers a range of speeds which is sufficiently wide for hobbing all ordinary commercial gears. Should a finer feed be desired, change-gears for the new feed may be calculated from Formula (2), employing the cancellation method as explained in the following example.

In order to explain the use of this method of determining change-gears for the hobbing machine, it will be of interest to carry out a problem taken from actual practice. Suppose it is required to determine the proper index and feed gears to use for hobbing a left-hand 20-tooth spiral gear of 7 diametral pitch (0.4488 inch normal circular pitch), which has a spiral angle of 17 degrees, 34 minutes, using a right-hand hob. Assuming that it is desired to use a feed of 0.0625 inch per revolution of the gear blank, we determine the index gears by substitution in Formula (1):

$$\begin{aligned} \frac{30}{20 + \frac{0.0625 \times 0.30182}{0.4488}} &= \frac{30}{20.04203} = \frac{\text{drivers}}{\text{driven gears}} \\ \text{Log } 30 &= 1.4771210 \\ \text{Log } 20.04203 &= 1.3019421 \\ \text{Log ratio} &= 0.1751789 \end{aligned}$$

Two, four or six gears may be used in the indexing train, and from Table II, which gives the logarithms of various gear

TABLE I. RATES OF FEED AND FEED GEARS FOR BARBER-COLMAN NO. 12 GEAR-HOBGING MACHINE

Feeds per Revolution, Inches	Driver	Driven	Driver	Driven	Feeds per Revolution, Inches	Driver	Driven
0.01500	24	60	36	72	0.06000	48	60
0.01875	24	72	36	48	0.06429	48	56
0.02000	24	72	48	60	0.07000	56	60
0.02333	24	72	56	60	0.08034	60	56
0.02500	24	..	..	72	0.08750	56	48
0.03000	24	..	..	60	0.09000	72	60
0.03750	36	..	..	72	0.09375	60	48
0.04125	33	..	..	60	0.10000	48	36
0.04500	36	..	..	60	0.11250	72	48
0.05000	48	..	..	72	0.12500	60	36
0.05454	24	..	..	33	0.15000	72	36

Machinery

ratios that may be employed on the No. 12 Barber-Colman gear-hobbing machine, we select a pair of gears the ratio of which is such that the logarithm of this ratio is as nearly as possible equal to the logarithm of the ratio obtained from Formula (1). Reference to Table II will make it evident that the gears which come closest to this value have 45 and 30 teeth, respectively, the logarithm of the ratio of these gears being 0.1760913. But the difference between this logarithm and the logarithm of the ratio obtained from Formula (1) is too great, and so it becomes necessary to use four gears in the index train. To determine the proper gears to employ for this purpose, the following method of procedure is employed:

$$\begin{aligned} \text{Log of required ratio} &= 0.1751789 \\ \text{Log of ratio } 54:37 \text{ from table} &= 0.1641921 \\ \text{Difference} &= 0.0109868 \\ \text{Log of ratio } 40:39 \text{ from table} &= 0.0109954 \end{aligned}$$

$$\text{Log of error} = 0.0000086$$

In this way we find that an index train consisting of gears with 54, 37, 40 and 39 teeth will give the required result. Probably it will have been observed that the preceding result was obtained by selecting from the table of gear-ratio logarithms two values whose sum is nearly equal to the gear-ratio logarithm obtained from Formula (1). A few trials are sometimes necessary to reduce the error to a point where it may be safely disregarded. There are other gear-ratios which have a value very close to 1 to 1, and if the first ratio selected, i. e., the ratio 54 to 37 in the preceding case, is as large as possible, the probability of the difference of the logarithms lying close to the value of a second gear-ratio logarithm which may be found in the table will be materially increased.

It will be recalled that it was decided to use a feed of 0.0625

TABLE II. AVAILABLE RATIOS FROM INDEX GEARS FURNISHED WITH NO. 12 BARBER-COLMAN GEAR-HOBBIING MACHINE, AND LOGARITHMS OF GEAR RATIOS

Driver	Driven	Log Driver Driven	Driver	Driven	Log Driver Driven	Driver	Driven	Log Driver Driven	Driver	Driven	Log Driver Driven	Driver	Driven	Log Driver Driven	Driver	Driven	Log Driver Driven
60	59	0.0072993	59	54	0.0384582	48	40	0.0791812	48	37	0.1130395	58	40	0.1613680	72	43	0.2238640
59	58	0.0074240	47	43	0.0386294	54	45	0.0791812	39	30	0.1139433	48	33	0.1627273	57	34	0.2243960
58	57	0.0075531	45	41	0.0404286	59	45	0.0806559	56	43	0.1147195	54	37	0.1641921	56	33	0.2296741
57	56	0.0076869	33	30	0.0413926	47	39	0.0810333	43	33	0.1149546	57	39	0.1648103	58	34	0.2319491
49	48	0.0089549	54	49	0.0421977	41	34	0.0813050	60	46	0.1153935	60	41	0.1653674	41	24	0.2325727
48	47	0.0091433	43	39	0.0424039	58	48	0.0821868	47	36	0.1157954	72	49	0.1671364	57	33	0.2373610
47	46	0.0093401	41	37	0.0445822	40	33	0.0835461	59	45	0.1176395	59	40	0.1687920	59	34	0.2393731
46	45	0.0095453	40	36	0.0457575	57	47	0.0837770	54	41	0.1196099	49	33	0.1716822	72	41	0.2445486
41	40	0.0107239	60	54	0.0457575	45	37	0.0850108	45	34	0.1217336	58	39	0.1723634	60	34	0.2466724
40	39	0.0109954	48	43	0.0477727	56	46	0.0854302	49	37	0.1219944	45	30	0.1760913	59	33	0.2523381
37	36	0.0118992	37	33	0.0496878	72	59	0.0864805	57	43	0.1224064	36	24	0.1760913	43	24	0.2532573
34	33	0.0129650	46	41	0.0499739	60	49	0.0879546	40	30	0.1249387	72	48	0.1760913	72	40	0.2552725
60	58	0.0147233	45	40	0.0511525	49	40	0.0881361	48	36	0.1249387	60	40	0.1760913	54	30	0.2552725
59	57	0.0149771	54	48	0.0511525	59	48	0.0896108	72	54	0.1249387	54	36	0.1760913	60	33	0.2596374
58	56	0.0152400	34	30	0.0543576	48	39	0.0901766	60	45	0.1249387	59	39	0.1797874	72	39	0.2662679
56	54	0.0157942	41	36	0.0564814	37	30	0.0910804	58	43	0.1299595	56	37	0.1799863	56	30	0.2710667
49	47	0.0180982	49	43	0.0567276	58	47	0.0913301	54	40	0.1303338	72	47	0.1852346	45	24	0.2730013
48	46	0.0184834	56	49	0.0579919	57	46	0.0931171	46	34	0.1312789	46	30	0.1856365	57	30	0.2787536
47	45	0.0188854	47	41	0.0593140	72	58	0.0939045	49	36	0.1338936	60	39	0.1870867	46	24	0.2825466
45	43	0.0197440	39	34	0.0595857	41	33	0.0942700	45	33	0.1346986	57	37	0.1876732	58	30	0.2863067
43	41	0.0206846	54	37	0.0602959	46	37	0.0945561	56	41	0.1354041	37	24	0.1879905	72	37	0.2891308
41	39	0.0217193	46	40	0.0606978	56	45	0.0949755	41	30	0.1356626	56	36	0.1918855	47	24	0.2918867
60	57	0.0222764	45	39	0.0621479	30	24	0.0969100	59	43	0.1373835	72	46	0.1945747	59	30	0.2937307
59	56	0.0226640	43	37	0.0652668	45	36	0.0969100	33	24	0.1383027	47	30	0.1949766	60	30	0.3010300
39	37	0.0228629	57	49	0.0656788	60	48	0.0969100	47	34	0.1406190	58	37	0.1952263	48	24	0.3010300
57	54	0.0234811	56	48	0.0669468	59	47	0.0987541	54	39	0.1413292	57	36	0.1995724	72	36	0.3010300
36	34	0.0248236	48	41	0.0684573	54	43	0.0989253	57	41	0.1430910	54	34	0.2009149	49	24	0.3099849
49	46	0.0274383	54	46	0.0696360	49	39	0.0991315	46	33	0.1442439	59	37	0.2026503	72	34	0.3258536
48	45	0.0280287	47	40	0.0700379	58	46	0.1006702	60	43	0.1446828	48	30	0.2041199	72	33	0.3388186
46	43	0.0292893	40	34	0.0705811	72	57	0.1014576	56	40	0.1461280	72	45	0.2041199	54	24	0.3521826
60	56	0.0299633	40	39	0.0716932	43	34	0.1019896	48	34	0.1497623	58	36	0.2071255	56	24	0.3679768
58	54	0.0310342	39	33	0.0725507	57	45	0.1026624	58	41	0.1506441	60	37	0.2099496	57	24	0.3756637
43	40	0.0314085	58	49	0.0732319	47	37	0.1038962	34	24	0.1512677	39	24	0.2108534	72	30	0.3802112
40	37	0.0338583	57	48	0.0746337	60	47	0.1060534	47	33	0.1535840	49	30	0.2130748	58	24	0.3832168
39	36	0.0347621	56	47	0.0760901	46	36	0.1064553	57	40	0.1538149	54	33	0.2138799	59	24	0.3906408
37	34	0.0367228	43	36	0.0771660	49	46	0.1080942	43	30	0.1563472	59	36	0.2145495	60	24	0.3979401
49	45	0.0369836	49	41	0.0774122	72	56	0.1091445	56	39	0.1571234	56	34	0.2167091	72	24	0.4771213
36	33	0.0377886	72	60	0.0791812	58	45	0.1102155	59	41	0.1580681	60	36	0.2218488	..	..	.....
..	..	.....	36	30	0.0791812	..	..	.....	49	34	0.1597172	40	24	0.2218488	..	..	.....

inch per revolution of the gear blank. Substituting this value in Formula (2), we have:

$$\frac{F}{0.0625} = \frac{625}{750} = \frac{60}{72} = \text{drivers} \\ \frac{0.075}{0.075} = \frac{750}{72} = \text{driven gears}$$

Checking this calculation for error, we have:

$$\begin{array}{r} 30 \\ \times 1.496854 \\ \hline 20.4203 \\ 54 \quad 40 \quad 1.496881 \\ \times \quad \times \quad \times \\ 37 \quad 39 \quad 1 \\ \hline 1.496881 \\ 1.496854 \end{array}$$

0.000027 = error in index ratio.

It will be recalled that the index constant of the No. 12 Barber-Colman gear-hobbing machine is 30; therefore, the actual error in indexing has a value of:

$$\frac{0.000027}{30} = 0.0000009 \text{ inch.}$$

With the exception of the gear-ratio logarithms, the preceding calculations were made for five-place logarithm tables. Slightly more accurate results would be obtained with seven-place tables, and for this reason the results presented in Table II were carried out to the seventh decimal place. The gear-ratio logarithms are calculated by subtracting the logarithm of the driven gear from the logarithm of the driver, and Table II includes all possible combinations of gears which may be obtained from the change-gears supplied with the No. 12 Barber-Colman gear-hobbing machine. As each special gear which is added to the list admits of introducing a number of new combinations, it will be evident that the table of gear-ratio logarithms can be extended to include a sufficient range of four gear combinations to obtain any ratio that may be desired for hobbing all gears that come within the range of the machine. The six gear combinations are obtained by a

further application of the same principle employed in selecting four gear trains; and the sum of any three-ratio logarithms must very nearly equal the value of the logarithm of the required ratio.

* * *

IMPORTANT POINT IN JIG DESIGN

In the design of jigs for two pieces which are to be fastened together by means of bolts or screws, it is important to drill the work in such a way that the tendency of the drill to run out of its true path will not cause serious trouble. An example of this kind is shown in the accompanying illustration in the two halves of a bearing A and B, which are bolted together through the holes C and D. In designing a jig for pieces of work of this kind, it would be necessary in order to obtain the best results to start drilling from the surfaces at G and H and from E and F. If this were done, the holes would match perfectly at the points of junction of the two pieces, and although there might be some variation at the outer ends of the holes, this would not cause trouble in alignment.

A. A. D.

* * *

For drawing temperatures between 650 degrees F. and 1000 degrees F., lead or a mixture of two parts of potassium nitrate and three parts of sodium nitrate may be used.

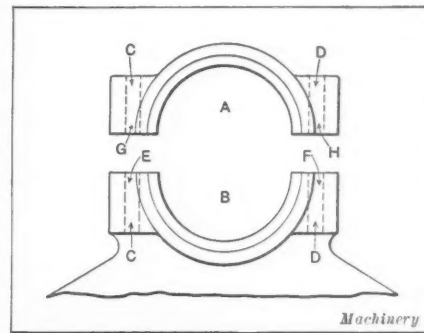


Diagram illustrating an Important Point in Jig Design

STRENGTH OF OXY-ACETYLENE WELDS*

BY S. W. MILLER†

With regard to the strength of welds, the author knows of no comprehensive tests that have been published, and does not believe that any investigations that have been made are complete enough to warrant accurate conclusions, particularly when modern welding practice is considered.

Cast Iron

In the case of cast iron, it is well known that the weld is stronger and less brittle than the original material; that is, as far as any ordinary cast iron is concerned. An explanation of this is to be found in what may be called the "anatomy" of the weld. It is finer grained, and inasmuch as the welding rods have to be made of good material, it is generally of a better quality than the original casting. It is therefore hardly necessary to discuss in detail the strength of cast-iron welds.

Steel

With regard to steel the situation is very complicated. There are so many different kinds of steel, and they are used for so many different purposes and are subjected to so many kinds of strains that it is impossible to lay down any general rule as to the strength of welds in this material. It has been claimed that oxy-acetylene welds are brittle and hard, although they may have greater tensile strength than the original material. It is true that in the early days of oxy-acetylene welding, when torches did not give as nearly a neutral flame as they do at the present time, many welds were burnt, and were therefore brittle and hard. At the present time, however, any weld of this kind shows that the welder either had a poor torch or did not know how to handle it. Hardness and ductility are relative terms, and a weld in a very soft, ductile, low-carbon steel may be harder than the original material, while a weld made with the same welding wire in a much harder steel of higher carbon may be softer than the original weld. In the former case, the original material may be more ductile than the weld, while the opposite may be true in the case of a harder original material. Again, the effect of the heat on the added material will be approximately the same in both cases. It is not true, however, that the effect of the heat will be the same on the original material in both cases. In the case of the soft ductile steel, the tensile strength of the weld will undoubtedly be higher than that of the original material, while in the other case the tensile strength will be less, and it may even happen, in the second instance, that the material just next to the weld will be so badly damaged by the heat that the test piece will break there, and not in the weld or some distance away from it. In the case of the higher carbon steels, there is still another action, in that the material next to the

* For other information on oxy-acetylene welding, see "Oxy-Acetylene Welding Practice," March, 1916, and articles there referred to.
† Address: Rochester Welding Works, Rochester, N. Y.

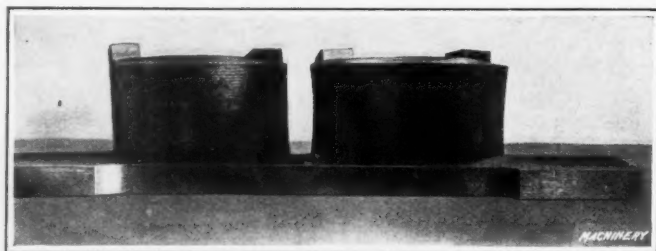


Fig. 2. View from above of Test Specimens shown in Fig. 1

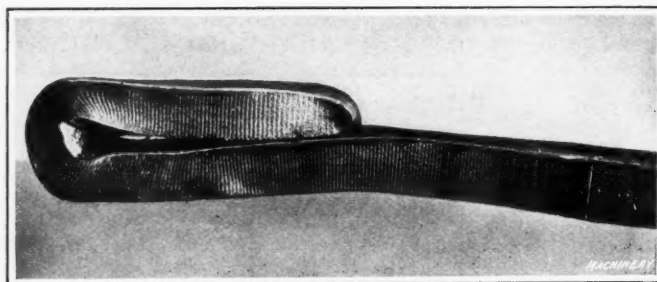


Fig. 3. Test Specimen bent Cold, showing Ductility of Weld

weld and in other places, where the heat is high enough, is decarburized. The extent of this decarburization varies with the intensity of the heat and the time to which the piece is subjected to it. A higher temperature and longer continued heating remove more carbon. This action is not due to anything except the heat and the presence of the oxygen in the air, and would occur with any method of heating. Another thing that occurs with very high carbon steel, such as tool steel, is the burning of the original metal in the vicinity of the weld. This applies particularly to tool steel, and an examination of many specimens microscopically indicates that it is not possible to weld high-carbon steel without burning it. Of course, it is possible to secure a union that may be strong enough for certain purposes, but the material next to the weld will not be sound, and no method of annealing or heat-treatment will cure steel that is really burnt.

Ductility of Steel Welds

With regard to the ductility of steel welds, Figs. 1 and 2 show some test pieces, nearly full size, before and after bending, the weld being made in the center of the test piece. It certainly cannot be claimed that such welds are brittle or lack ductility. Fig. 3 shows, full size, a similar weld made in the same material and flattened cold. This also shows that a properly made weld is ductile. In the particular cases shown, the test pieces broke about 2½ inches from

the weld, but the material from which they were made was a very low carbon steel of 47,500 pounds tensile strength; hence, it would naturally be expected that such material would not break in the weld. With steel of about 55,000 pounds tensile strength, a welded test piece will usually break in the weld, giving a tensile strength of about 52,000 pounds. The elongation in such cases may run as high as 20 per cent, that of the original material being in the neighborhood of 32 per cent. The elastic limit will be about 33,000 pounds, against 35,000 pounds in the original. So much depends on the material with which the weld is made, on the method of making it, and on the heat-treatment after it is made, that it is impossible to give any specific results. All the published tests that the author has seen are, in his opinion, deficient in essential information. For example, in one report of some tests made about two years ago, calling the average of the original pieces 100 both for tensile strength and elongation, the average for the welds untreated in any way was only 85 for tensile strength and 22 for elongation. The author's belief is that these welds were in some way improperly made, as he has never obtained such low figures as these. The lowest results given are for tensile strength, about 80 per cent of the original, and for elongation, 9.3 per cent of the original. The latter very low result indicates clearly that there was a wide variation in the actual condition of the different welds which should not exist. It is admitted that there will be some variation, but the author has repeatedly obtained results with a maximum variation of 10

per cent in elongation, 6 per cent in elastic limit and 5 per cent in tensile strength. As has been stated before, it cannot be claimed that any weld is as good as the original material; and particularly in the case of steel, which is generally used in places where great strength and high physical qualities are required, care should be taken and good judgment used in selecting the method of joining. There is, above all, one thing that should be carefully considered, and that is, whether a welded piece is to be subjected to alternating stresses or shock. This is the worst condition to which a weld can be subjected, and it is well known that a piece of over-annealed steel will not stand these stresses nearly as well as a piece that has been properly refined by correct heat-treatment.

Strength of Welds in Non-ferrous Metals

With regard to the strength of welds in other metals, the author is not acquainted with any conclusive published tests, and is unable to give any results. However, in a general way, if the welds are made carefully with a good torch and the proper materials, the results will usually be satisfactory, as in most cases such metals as brass, bronze, aluminum and copper are not subjected to great stress, although, of course, there are exceptions to this; so that a weld in these materials will usually be amply strong, even if not equal in strength to the original material. One point, however, should be noted, which is that in the case of brass and bronze castings subjected to pressure, it is good practice, if indeed not absolutely necessary, that the whole piece be annealed at the proper temperature in order to relieve the cooling strains caused by welding. What this annealing is depends upon the alloy, and no definite instructions can be given. The time and temperature of annealing and the rate of cooling all have their effect, and have to be determined in each case.

* * *

MACHINERY CLUB OF CHICAGO

The Machinery Club of Chicago was organized May 1 with 154 charter members. The purpose of the club is to bring together at least once a week the salesmen and heads of the different machinery houses in Chicago. The club meets each Monday in the restaurant of the Chicago & North Western Railway terminal, in the midst of the machinery district on the West Side. The officers of the club are as follows:

President, Clyde W. Blakeslee, Chicago manager, Abrasive Material Co.

First vice-president, E. P. Welles, president and general manager, Charles H. Besly & Co.

Second vice-president, H. A. Stocker, president, H. A. Stocker Machinery Co.

Third vice-president, E. L. Essley, president, E. L. Essley Machinery Co.

Treasurer, A. L. Beardsley, Chicago manager, Cleveland Twist Drill Co.

Secretary, D. F. Noble, credit man, E. L. Essley Machinery Co.

The directors are Robert E. Cuthbertson, manager, Manning, Maxwell & Moore; F. L. Peterson, manager, Hendey Machine Co.; Hiram N. Cudworth, Chicago manager, Norton Grinding Co.; Herbert E. Nunn, western sales manager, Cleveland Automatic Machinery Co.; George M. Pearse, western representative, Brown & Sharpe Mfg. Co.; and E. L. Beisel, Chicago manager, Gardner Machine Co.

The resident membership fee is \$5, and the annual dues \$5; the non-resident membership fee is \$2 and annual dues \$3.

* * *

MONTHLY MEETING OF A. S. M. E.

The final meeting of the season 1915-1916 of the New York section of the American Society of Mechanical Engineers was held at the Engineering Societies Bldg., Tuesday evening, May 9. The subject for discussion was a report upon efficiency tests of a 30,000 K. W. (40,000 H. P.) cross-compound steam turbine, by Henry G. Stott and W. S. Finley, Jr.

The New York section will not discontinue its activities, however, through the summer; it has planned to make excursions to nearby points of mechanical and engineering interest about every two weeks through the season. The first one of these excursions was made to the Essex Station of the Public Service Corporation of New Jersey, Saturday afternoon, May 20.

GRAPHITE AS A LUBRICANT

BY C. H. BIERBAUM*

The rate of increase of the use of graphite for lubricating purposes is nothing less than surprising. Concerning the general increase of the consumption of graphite, *Mineral Industry*, 1914, says, "Fifteen years ago 75 per cent of the world's supply was used for crucibles and 4 per cent for lubricants; now 30 per cent goes into lubricants and 50 per cent into crucibles." The world's total supply of graphite for 1913 was somewhat in excess of 100,000 tons; 30 per cent of this amount, or 30,000 tons, accordingly, stands as the world's consumption of graphite for lubricating purposes for the year 1913.

The constantly increasing use of graphite for lubrication is the more surprising when we consider the impurities which many of the best lubricating graphites now on the market still contain. These impurities have rendered their use, if not absolutely harmful, at least undesirable, for it is always difficult to say, concerning any particular grade of lubricating graphite, how much of the pure graphite is necessary to counteract the effect of the impurities, and in many grades the nature of the impurities is such that their harmful effects cannot be counteracted by the pure graphite. This condition is clearly shown by the photomicrographs reproduced herewith. Fig. 1 shows the surface of a cut tooth of a bronze gear in a new Lobe pump, and Fig. 2 shows the surface of a tooth after the pump has been in service for a month. This pump was used for pumping a mixture of graphite and water against a head of two pounds per square inch. The mixture had the consistency of cream; that is, it was made up of substantially equal parts of water and air floated lubricating graphite. It should be noted that the streaks in Fig. 2 run at right angles to those in Fig. 1. Fig. 1 shows the milled surface as left by the gear cutter; this appears smooth to the naked eye but under the microscope shows slight streaks, as illustrated. Fig. 2, on the other hand, shows distinct cutting due to an abrasive, and in Fig. 3 the abrasive is shown magnified on the same scale (one hundred diameters). This material is practically pure quartz or white sand, and it is of interest to note the extreme variation in the size of these particles. In amount, it represents substantially 3 per cent of the total weight of the graphite from which it was taken. However, it does not represent all of the impurities which this graphite contained; it is only a portion that was washed out from the rest and constitutes the more abrasive part.

It is evident that these impurities have made many enemies of graphite, but nevertheless beneficial results have been obtained by its use in spite of its drawbacks. All criticisms of graphite can be traced directly to its impurities. The impurities in lubricating graphite may be divided into two classes: the harmful and the inert—that is, those that have a positive abrasive effect and those that act neither as abrasives nor lubricants. Artificial graphite may be made very high in carbon, but since it is a by-product of the electric furnace process of making silicon carbide, it is likely to contain traces of this, which is very objectionable, as silicon carbide is one of the most abrasive substances known. In the natural graphites the objectionable impurity most commonly found is silica, or common sand.

The harmfulness of the impurities depends also on the size of the particles. If the size of the abrasive particles in a graphite is greater than the average thickness of oil film, their abrasive effect will be greatest in a bearing running under uniform pressure. On the other hand, in a reciprocating bearing under high duty, where the oil film is alternately broken and restored, all the different sizes or particles of the abrasive material may come into play, and it is in the latter class of bearing that pure graphite is most essential and that abrasive impurities are most harmful.

Among the many impurities in the natural graphite we find some that are not, by nature, abrasive, but are highly undesirable and injurious to bearings. To illustrate, let us take the particle of so-called flake graphite shown in Fig. 4, where we have alternating layers of mica and graphite held together in a manner capable of sustaining considerable compression. Let

* Vice-president, Lumen Bearing Co., Buffalo, N. Y.

us imagine stopping an engine at night with a layer of these laminated particles between a heavy crankshaft and a babbitt or lead bronze bearing; the inevitable result will be "pock-marking" of the bearing surfaces. The effect on a reciprocating bearing would be equally undesirable; and it will be readily seen that the jamming effect produced in

a ball bearing by the use of this graphite would be ruinous. Yet this is a fair representation of the structure of Ticonderoga flake graphite or the micaceous graphites. For lubrication, the graphite should be such as to permit an infinite divisibility while in contact with bearing surfaces. The very thin layer of graphite between the layers of mica in the material shown in Fig. 4 possesses this property when completely separated from the mica; that is, if this micaceous graphite were ground fine enough and then had all the mica and other impurities completely eliminated the resulting product would be a very high grade of amorphous graphite.

The degree of fineness to which the graphite should be ground is also of importance. It should be uniformly fine enough to practically maintain suspension in the oil or grease, so as to permit of the application of the lubricant without undue difficulty due to settling, and it should be fine enough to enter properly between the bearing surfaces without clogging; this will allow it to flow freely in the oil film between the bearing surfaces. For all ordinary lubrication with the lighter grades of machinery oil, none of the graphite particles should be coarser than 0.0003 inch; grades of graphite used with greases or heavy oils would be satisfactory if ground considerably coarser, owing to the correspondingly thicker oil film which exists with these lubricants. Excessively fine grinding solely for the purpose of securing permanent suspension in the oil is not desirable for the following reasons: First, it is a physical impossibility to keep mechanically divided pure graphite permanently suspended in a pure lubricating oil; and second, the larger the particle of graphite in the oil film of a bearing, the more efficient is the lubrication secured.

There being a positive capillary affinity between graphite and the oils, it is possible to grind the graphite so fine that it will remain in a suspended condition for a time, but in this fine state of subdivision the particles would, by the

Brownian action, or vibration, be brought in contact with each other, coalescing and forming larger and larger masses. These larger particles, then, would tend to settle, through the action of gravity. This action is clearly illustrated in the photomicrograph shown in Fig. 5.

The friction of a bearing is not reduced owing to the

presence of floating graphite in a perfect oil film, but upon the destruction of the oil film when the bearing surfaces approach each other and the graphite comes into play. Now it is evident that as the bearing surfaces approach each other, the largest particles are intercepted first while the smallest particles will flow freely from between the bearing surfaces. If the largest particles are 0.0003 inch and the smallest particles 0.000005 inch, it is obvious that the larger particles will allow the bearing surfaces to approach each other to within 0.0003 inch, whereas the smaller particles will allow these surfaces to approach each other to within 0.000005 inch. When we consider that the mass of a particle 0.0003 inch in diameter is more than 200,000 times that of a particle 0.000005 inch in diameter we will appreciate the folly of grinding graphite to such a degree of fineness. It has been found that grinding finer than 0.000005 inch is necessary to produce permanent suspension, and even under those conditions the effects shown in Fig. 5 are produced.

The carbon content of a graphite is not an indication of its lubricating value, for the reason that the percentage of amorphous carbon in some varieties is comparatively high. Amorphous carbon, or carbon not completely graphitized, can best be classified as an inert impurity; its presence always shows extreme blackness. This is true of another common impurity, hydrogen, or a hydro-carbon; this also is black, whereas the purest graphite is a dark steel gray when mixed with a clear oil. The chemical laboratory can only give valuable information on the subject of the graphites when the work is done by an expert or specialist.

Impurities such as mica, silicon, calcite, feldspar, iron oxide, alumina, clay, and the like, to the amount of over 13 per cent, have been removed from some of the best lubricating graphites now on the market by the Bierbaum process. Graphite purified by this process is used in the lubricating compound called "Lesoyl."



Fig. 1. Section of Tooth of Bronze Gear not subjected to Abrasive Action—Magnification 100 Diameters



Fig. 2. Section of Tooth of Bronze Gear after being subjected to Abrasive Action—Magnification 100 Diameters

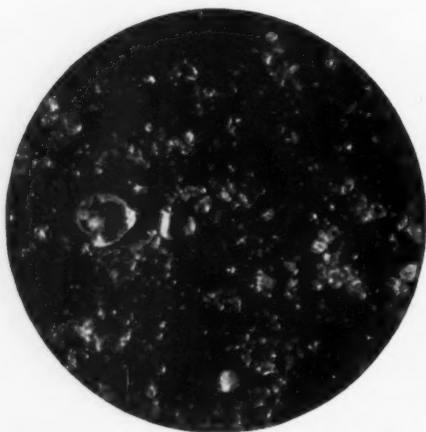


Fig. 3. Photomicrograph of Graphite containing Quartz Particles magnified 100 Diameters

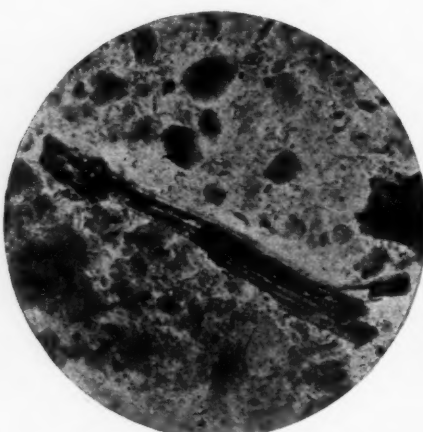


Fig. 4. Flake Graphite having Alternate Layers of Mica and Graphite—Magnification 100 Diameters

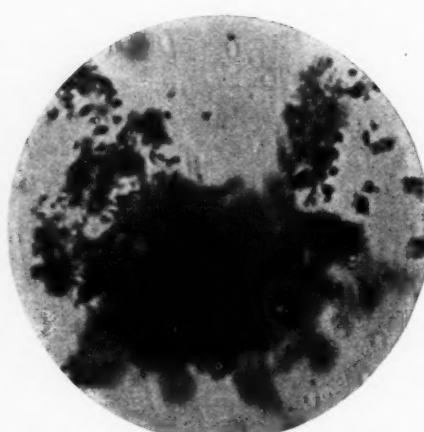


Fig. 5. Photomicrograph showing Coalescence of Particles of Graphite—Magnification 1600 Diameters

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ESTIMATING THE COST OF MACHINE WORK

It is indeed refreshing to find the much lampooned household plumber justified by so good an authority as your own columns. If the implication conveyed by the editorial on page 780 of the May number, concerning "Estimating the Cost of Machine Work," is in point, and if the plumber can show as good reasons for his traditional vagaries as can the small manufacturer for not estimating and bidding on small jobs, then the knight of the soldering iron must indeed find full extenuation at your hand.

In the first place, the present is an inopportune time to raise this question of estimates, because so much work, particularly special tool work, has been done and is being done on an hour rate basis. So long as orders are freely given on that basis, why estimate? To do so appears to be a needless and futile expenditure of time. Prior to the present pressing times, bids could be secured on orders of almost any kind and size, but according to my observation the small shops were those which would "make a price," while larger shops would exact the hour rate basis—possibly impelled to do so because of early experiences which they have survived, and possibly because a well established reputation enabled them to enforce the exaction.

The nature of the illustration offered by your correspondent leads to the assumption that he refers to small jobs involving a single piece or device, or work of such restricted extent as to neither involve nor warrant special manufacturing equipment.

In cases judged to be akin to the example presented, the drawings or prints and other specifications are frequently inadequate. Replete with such archaic expressions as "running fit"; "absolutely straight"; "absolutely square," they call for further information. Two of the first questions which invariably arise are, "How accurate? What are the tolerances?" Shafts and bearings are depicted, dimensioned as of the same size, with no clue as to the running speed or other conditions from which to guess suitable relative sizes. Round holes are shown with no indication of their ultimate function or the precision of their size or relation: should they be merely drilled; or drilled and reamed; or must they be bored with regard alike to accuracy of spacing and parallelism? Were a substantial order in view, one might well afford to make a trip, or write, or otherwise ascertain definitely what is required, and further revise the drawings to a manufacturing basis so as to distinctly impart to the workmen just what they were to perform and within what degree of accuracy. But to undertake the same procedure for every small job submitted by a prospective customer would consume time that could be better devoted to securing more profitable orders. Indeed, to what extent could a contractor realize on the extra effort? Will your "engineer of wide experience" pay me or anyone for making a painstaking estimate; or will he give his order to Jones who bids \$30 less on the basis of a guessed weight and an estimated (?) cost per pound? Unless your engineer is an abnormal altruist, Jones will secure the order if he is a responsible party, even if he is believed to have bid in on a losing basis.

But even if the drawings are entirely adequate, with full information expressed in terms readily intelligible to the workmen, there are two other principal factors to be considered in the production of any piece—the individual factor or personal equation of the workman, and the individuality of the piece to be made.

In some respects the personal equation is the least certain and least dependable. Among experienced, competent workmen there is a distinct difference in their rates of mental and

bodily action, and consequently in their individual rates of performance. These rates are further varied by the condition of bodily health at any given time. Temperament is not confined to artists. An exceptionally good workman will sometimes utterly "fall down" on a job, due to temporary bodily infirmity or mental disquietude. A price may be based upon the rate of performance of a rapid worker, and when the work comes to hand it must be given to a slow worker. Therefore, in work of duplication, *i. e.*, making a single piece or set of pieces from a drawing or from a sample piece or set, the personal equation has a stronger bearing on cost and price than does the cutting capacity of a machine tool. In the case of reduplication, *i. e.*, the making of a multiplicity of pieces or sets, the cutting capacity is of greater importance, first because the employment of special tools renders the personal rate more uniform, and again, in making an extended number of parts there is opportunity to substitute a more rapid worker for a slow one, which substitution is usually impracticable on the small job.

The individuality of the piece to be machined is an important consideration. If it is a casting of complicated form—or even of apparently simple form—it is not an unknown occurrence to be obliged to materially modify or to entirely remake a pattern. Apparently simple operations sometimes develop unforeseen difficulties. After a casting has been half or two-thirds machined, a spongy spot or a deep blow-hole develops at a point where it cannot be tolerated. One surface or portion of a casting machines freely and another portion develops hard spots which cause a reduction in the rate of cut, or entirely prevent further machining. A piece of steel may likewise develop some flaw after the machining has proceeded substantially. In any of these cases the foundry or the steel mill may replace the defective material, but neither will reimburse the contractor for his fruitless work. The cost of doing that work over may materially curtail or entirely cut out his estimated profit.

In the case of extended manufacture, the cost of the pattern change will be spread over the entire lot; the variation of the labor cost from the estimated figure may be taken care of; the cause of the spongy iron and of the blow-holes will probably be located and its effects will be corrected. In short, the contractor has steerage way which he has not in the case of a small job. In any estimate there is a factor of guesswork, as evidenced by the fact that every experienced contractor includes some allowance for contingencies—a factor of safety, as it were. There seems to be only one sane way in which to estimate on such small jobs, and that is to allow a factor of safety that will be ample to care for the possible accumulation of all these variable factors, *i. e.*, guess at the probable outcome of the work.

With reference to the three prices quoted in the example presented, there seems to be a note of reproach at their disparity, and the statement is ventured that only one of the prices can be correct. To my mind all of the prices may have been correct, and again all of them may have been wrong. From a purely commercial viewpoint, the lowest price was the only correct price if it were made by a responsible party. As your correspondent gives no figures showing what the work actually cost at the factory, there remains the possibility that none of the prices sufficed to cover the cost and yield a profit, in which case none of them would be correct.

Costs and prices vary materially between different shops, and their correctness—better, their propriety—is to be determined usually by the conditions prevailing in the shop doing the work, rather than by the acceptability of the price to the buyer.

A concern that buys its castings pays a higher price for

them than does the concern that makes its own castings—usually. A concern that buys substantial regular tonnage of medium and heavy weight castings usually enjoys a better price than does the concern that buys only light weight castings and in relatively small quantities.

Operations in one shop may be such that the job can be carried along with other work at a *pro rata* expenditure of time, whereas in another shop the work must proceed by itself and sustain the cost of "straight time" unshared by any other work. One shop may be able to use some rig that has been used for a previous order and that materially facilitates the prosecution of the work, while another shop may have no such time-saver at its disposal, or may have only meager facilities of any kind. Different establishments have diverse views as to what constitutes a reasonable profit, and some are not satisfied with a reasonable profit. Equally diverse is the allowance for contingencies.

A very small shop frequently has an insignificant overhead burden, because the proprietor himself works, besides keeping his books and attending to his correspondence. Almost everything received beyond his actual expenditures for rent, wages and material is net profit. The medium sized and large shop usually has a substantial charge for overhead that must be embodied in any estimate.

The fact that tenders vary is no indication of essential error in an estimate, but rather that conditions may be different in different shops, and that it may be advantageous to place the order with one concern rather than with another. There is always the further possibility, due to the ambiguities above indicated, that the drawings submitted may have been differently interpreted by different persons, one proposing to do much closer work than another.

Is it not fair to infer from the fact that your correspondent has for so many years been unable to interest "small manufacturers" in estimating, that those small manufacturers may be better acquainted than he with the pitfalls that are to be encountered in prosecuting such small contracts? Possibly some of them have memories of experiences more "lamentable" than their disinclination to make such estimates?

By the way, if we as Americans are so unprogressive, who is more progressive? Your correspondent omits to point out who is ahead of us. Can he secure bids on such work from across the water or from across the border? If he is correct, then what do the advertisements for contract work mean that are carried by all metal trade papers, including MACHINERY? Some of these advertisers solicit a print or sample on which to base a proposition despite the asseveration concerning American progressiveness in the line discussed. Some of the advertisers are certainly located here in this country, but, of course, there is no conclusive evidence as to their nationality.

Providence, R. I.

EDWIN C. SMITH

We have read the editorial in the May number on "Estimating the Cost of Machine Work," and wish to offer a few remarks on the subject from the standpoint of the shop, and especially of the small shop.

If the specifications of cylinder submitted were no more complete than the description, we do not wonder at the variation of estimates made, and if the specifications were more complete than this, it constitutes an exceptional case in specifications offered for estimates or quotations. In this particular case, were there any specifications of limits as to dimensions? Was the use to which the cylinder was to be put specified so that the required finish could be positively known? Was its use such that an absolutely clean surface was required, as would be the case in a hydraulic or air cylinder? Were the patterns that had to be made to be used for single castings only, or were they to be so made that they would stand up for continuous use? We could ask a number of other questions that should be known in order to make an intelligent estimate, on the job.

Our attention was especially called to this case because within ten minutes after reading the article we were called on the telephone by someone fifty miles away and asked to quote on reboring a four-cylinder automobile engine, making new

pistons, rings and piston pins. The person at the other end of the wire was quite "peevish" because we would not make a quotation on the job, although he was unable to give make of engine, bore, number of rings in pistons, amount required to be removed from cylinder walls, whether cylinders had open or closed ends, or any other essential information than that noted above.

The machine shop, and especially the small shop, is often asked to make estimates upon work with data varying all the way from motions made with the hands to complete blueprints. In many cases where estimates are requested from complete data, the request is not made with the intention of giving out the work but merely for the purpose of checking the manufacturers' own estimated cost. Frequently the estimator for the small shop is also the superintendent, foreman, sales manager, trouble man, time clerk and rate setter; he has duties in the shop which occupy a large part of his time and, therefore, does not have as much time to devote to these estimates as could be wished by the parties submitting them.

No lawyer would submit an opinion based upon the most careful statement of facts, gratis, nor would a physician furnish his estimate of the treatment necessary for any given ailment without compensation for his time and skill. We do not see why a machine shop should be called upon to furnish similar service without compensation.

In the case under discussion, the writer states that he sent the data to ten machine shops. It is a "cinch" that nine of them would get nothing for their estimate or quotation. We do not consider the variation of bids received for the work more than would be expected unless complete drawings and specifications were submitted and unless the shops to whom these were submitted were all equipped to do the work in the most efficient manner.

Moline, Ill.

REYNOLDS PATTERN & MACHINE CO.

ELGIN WATCH SCREW THREADS

In the March number of MACHINERY a table was published giving the dimensions of standard screw threads used by the Waltham Watch Co. As the products of this firm and those of the Elgin National Watch Co., of Elgin, Ill., are the two best known in the United States, the accompanying table giving

TABLE OF ELGIN WATCH SCREW THREADS

Diameter, Inches	Diameter, Millimeters	Threads per Inch	Diameter, Inches	Diameter, Millimeters	Threads per Inch
0.0132	0.33	360	0.0428	1.07	120
0.0148	0.37	320	0.0448	1.12	110
0.0168	0.42	260	0.0468	1.17	110
0.0208	0.52	220	0.0488	1.22	140
0.0228	0.57	260	0.0488	1.22	200
0.0248	0.62	220	0.0508	1.27	110L
0.0268	0.67	180	0.0548	1.37	180
0.0288	0.72	220	0.0608	1.52	110
0.0308	0.77	180	0.0608	1.52	110L
0.0308	0.77	220	0.0708	1.77	180L
0.0368	0.92	140	0.0768	1.92	110L
0.0368	0.92	220	0.0772	1.93	80L
0.0408	1.02	120L	0.0892	2.23	80L
0.0408	1.02	200	.....	....	...

Note: "L" indicates left-hand threads.

ing the dimensions of standard screw threads used by the latter firm appears to be a logical supplement to the table published in March. This table is taken from the Elgin material list issued in May, 1915.

New London, N. H.

GUY H. GARDNER

PLUG GRINDING FIXTURE—CORRECTION

An error appeared in my letter, "Plug Grinding Fixture," in the May number. Beginning on the thirteenth line, the sentence should read as follows: "The work is gaged by placing a parallel on top of the plug, and the distance between the under side of the parallel and the surface of the magnetic chuck is measured by means of a gage block or distance piece."

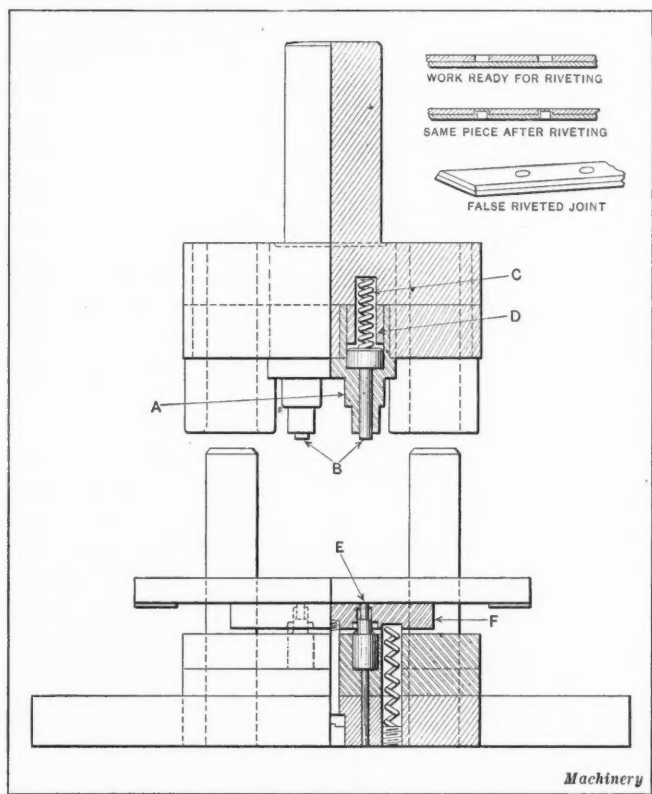
Plainfield, N. J.

J. B. MURPHY

FALSE RIVETING DIE

The term "false riveting" is used to denote a method of securing two pieces of sheet stock together by forcing metal from one sheet up into a hole punched in the other, and compressing this metal so that it is a tight fit in the punched hole. The following describes a punch and die for performing false riveting operations, and an example of false riveting is shown beside the illustration of the tool.

The upper member consists of a cast-iron punch-holder, which carries two steel riveting punches and guide pin bushings. Tool steel bushings *A* support the riveting punches *B* which protrude for a distance slightly greater than the thickness of the pierced stock, and are held out by compression springs *C*. Bushings *D* are driven into place and form abutments for the riveting punches. The lower member consists of a cast-iron shoe that supports a steel plate in which two punches *E* are mounted. *F* is the drawing plate which assists



Die used for False Riveting Operation and Examples of Work.

in forcing the metal from the lower piece up into the hole punched in the upper piece.

The operation of the punch and die is as follows: The two pieces of sheet metal—with the upper piece punched as shown in the top view—are properly located in the die by a gage. The upper member of the tool engages the work and forces it down onto punches *E* which force metal from the lower sheet up into the holes in the upper sheet. When plate *F* has reached the limit of its travel, pins *B* apply pressure from above and expand the metal in the holes in the upper sheet, thereby making a very tight joint.

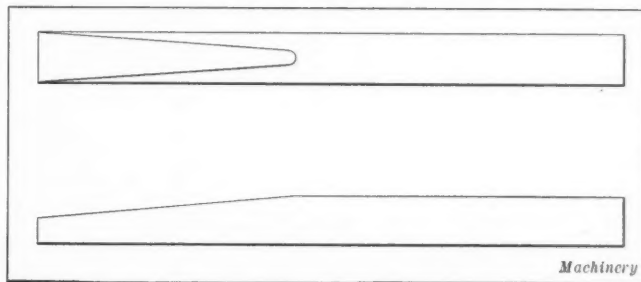
For light manufacturing, this method will be found to constitute a very satisfactory means of making joints. It can be used in cases where the employment of ordinary rivets is out of the question, because their raised heads would detract from the appearance of the finish applied to the work. Where pieces are joined by false riveting, they may be nickel-plated and polished, after which the joint will be practically invisible. Tests made of false riveted joints have shown that the metal forced up into the holes in the upper plate will break before the rivets are pulled out of the holes.

Chicago, Ill.

H. FIELD MCKNIGHT

SLIDING FIT FOR PILOT PINS

When it is required to provide a sliding fit for a pilot pin made of cold-rolled stock or drill rod, the following method



Reamer for finishing Holes to make Sliding Fit for Pilot Pins

will be found to give satisfactory results. First take a drill one size smaller than the stock and drill a hole in the usual way. Then take a piece of the drill rod that is to be used for making the pilot pin, and bevel off one side to form a reamer which is used for finishing the hole; this piece is then hardened and ground. By running this tool through the hole which is to receive the pin, a nice sliding fit will be obtained. When it is frequently necessary to machine holes for pins of standard sizes, it is a good plan to carry a number of these reamers in stock.

Milwaukee, Wis.

W. E. BUTLER

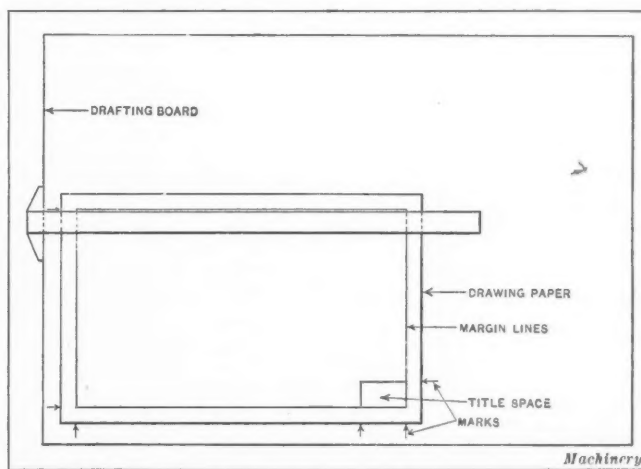
DRAFTING-ROOM KINK

The following describes a method of saving considerable time for tracers and draftsmen through having reference marks on the drawing-board to facilitate laying out border lines and title spaces without the necessity of making measurements. Many draftsmen are not careful about ruling margin lines and the space for a title at the time they start work, and if the drawing is not laid out in this way to correspond to the printed tracing cloth, there is a probability that some of the details or views on the paper will extend beyond the border lines. Especially is this the case if an attempt is made to crowd all views and details onto a single sheet.

When such drawings come to the tracer and it is found that they cannot be traced direct on a standard sized sheet, it is necessary to shift the tracing cloth to get all the views inside the border lines and title space, and this naturally results in the loss of considerable time. But if the draftsman has his drawing-board marked off according to the plan shown in the accompanying illustration, it requires but a few seconds to draw in the border lines and title space before he starts work, thus obviating trouble for the tracer and saving time for the draftsman. The reference marks which indicate the locations of the different border lines and title space lines are marked on the drawing-board with India ink, or cut in lightly with a knife, being laid off to correspond with the standard printed tracing cloth used in making tracings. The illustration shows a board laid off for a single size of drawing, but it would be practicable to lay off a single board with reference marks for a number of different sized sheets.

Chicago, Ill.

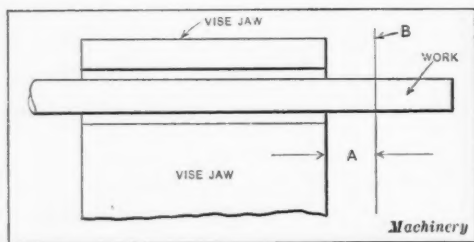
JAMES R. ALLAN



Rapid Method of laying out Border Lines and Title Space on Drawings

HACKSAW SETTING TO LENGTH

The accompanying illustration shows a useful kink for setting up a hacksaw machine for cutting off stock to a specified length. Its use saves the necessity of making several settings by the cut and try method. Referring to the illustration, it will be seen that the distance A from the edge of the



Method of setting up Work on Hacksaw to cut off Piece to Required Length

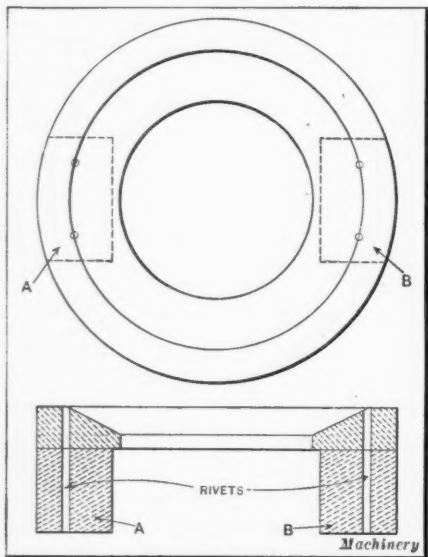
a distance equal to the length of the piece to be cut off plus the distance A from the edge of the jaws to the saw blade.

Worcester, Mass.

C. H. ANDERSON

TO PREVENT BROKEN TOOLPOST RINGS

Lathe operators often have work to do that requires the tool to be turned around to a position at right angles to the faceplate or chuck, and rather than take the time to swing the compound rest around they simply turn the toolpost to the desired position and tighten the tool in place. With the tool turned around in this way, there is no support under the ring, and when the screw is tightened there is a tendency for the pressure to cause the ring to bend between the T-slots of the compound rest, which sometimes results in breaking it. After breaking several rings in this way, it occurred to the writer



How to avoid breaking Toolpost Rings

that it would be possible to fit two small blocks on the under side of the ring as shown at A and B in the accompanying illustration. These blocks are made the same width and thickness as the T-slot in the compound rest and are riveted to the ring as shown.

HARVEY MEAD

HAND BENDING FIXTURE

Some time ago we received an order for 10,000 pieces of the form shown at A, and the small number of pieces called for naturally limited the amount of money which could be spent

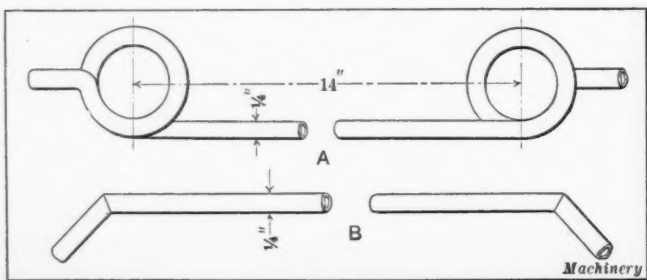


Fig. 1. Blank B with Ends bent to Angle of 60 Degrees and Finished Piece A

for tools. As a result, it was decided to employ some simple form of hand bending fixture, and the following describes the tool that was finally developed for the purpose. The blanks from which pieces A were formed were cut off from bar stock on a power shear, and each

end was then bent up to an angle of sixty degrees as shown at B. After the blanks had been prepared in this way, they were brought to the bending fixture on which the coils were wound, care being taken to keep the bent ends in line with the plane of the coils. After the forming operation was completed, the work was fitted to a gage, and if it did not fit this gage properly the piece was straightened out with a small hammer. After obtaining a little practice in operating the bending fixture, the boy employed to do the work became quite expert and was able to wind the coils so that they did not require straightening, at the rate of 250 per hour.

Memphis, Tenn.

JAMES ELLIS

TOOL FOR WINDING SPRINGS

The following describes a method of winding medium and heavy helical springs for use on jigs and fixtures, without having to gear up a lathe to attain the required lead for the spiral.

In addition to saving time, this method also makes it possible to wind springs of any lead, regardless of the change-gears which may be available. The spring is wound on an ordinary mandrel which is supported on centers and driven by a dog or chuck. The feed is disengaged and the winding tool is fed along by the spring as it is wound up on the mandrel. Provision may be made for winding a spring of any required lead by making the projection A proportional to the pitch. The lathe is driven at about the same speed as for threading, and the mandrel must be made of such a size that after the spring is removed, and unwinds slightly, it will be of the required size. The exact size of arbor to use is governed, of course, by the diameter of spring, and gage size of wire used.

J. B. M.

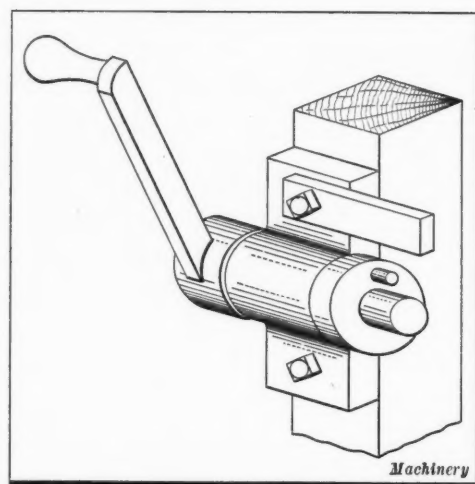
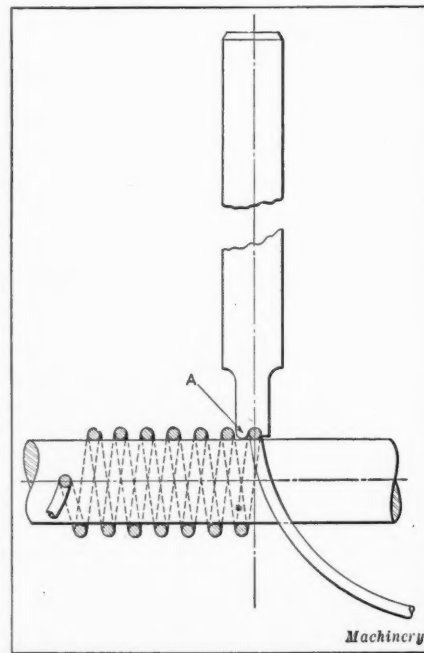


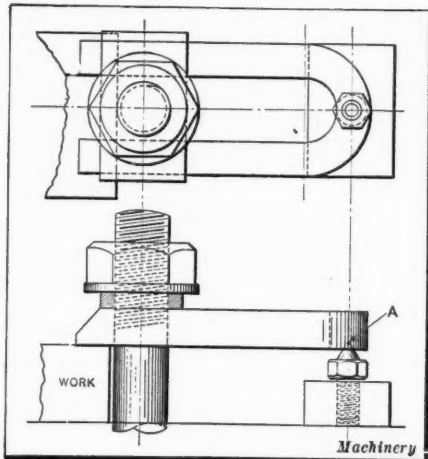
Fig. 2. Hand Bending Fixture used for making Pieces shown at A in Fig. 1



Method of winding Springs on Lathe without using Feed to control Lead of Spiral

RAPID CLAMPING DEVICE

The accompanying illustration shows a method of clamping work for drilling, milling, planing and similar operations, which does away with loss of time in hunting up suitable



Plan and Elevation of Clamp and Jack

Reference to the illustration will show that the clamp has a center hole drilled at A to receive the point of the jack screw.

Plainfield, N. J.

J. B. MURPHY

MONEL METAL PICKLING TRAYS

At the Pierce-Arrow Motor Car Co.'s plant in Buffalo, N. Y., where I worked out the pickling game on a large scale, we were at constant expense in replacing steel trays. Monel metal trays were later installed, and three years of constant use found these trays as good as new. Boiling sulphuric acid apparently had no effect on them.

Kenmore, N. Y.

GEORGE B. MORRIS

ABBREVIATED INDEX FOR MACHINERY'S HANDBOOK

The average draftsman does not use textbooks enough to remember the page numbers of the common subjects or tables without actually learning them. An easy way of memorizing and in the meantime a quick way of finding the page numbers is to compile an abbreviated index of about twelve or fifteen of the most used sections or tables. The accompanying illustration reproduces the blueprint of an abbreviated index of the data in MACHINERY'S HANDBOOK which I use most. The blueprint is pasted inside of the front cover where it can be found instantly.

The time spent in looking through the general index which

INDEX	
	PAGE
AREAS OF CIRCLES	48
BEAMS	338
BOLTS & NUTS	766
BORING BARS	1123
FILL. HEAD SCREWS	771
GAGES, WIRE & DRILL	392
GEARING, SPUR	549
JIG STANDARDS	943
LOGARITHMS	106
LOGS. OF TRIG. FUNCTIONS	201
MECHANICS	257
REAMERS, SHELL	1101
STRENGTH OF METALS	299
TAP DRILLS	867
TRIG. TABLES	156

Reproduction of Blueprint Page, 4% by 6% Inches, carrying Abbreviated Index to MACHINERY'S Handbook

this page saves amounts to a few hours in a year. Of course each user in compiling an abbreviated index will select the subjects to which he refers most.

Rockhampton, Australia.

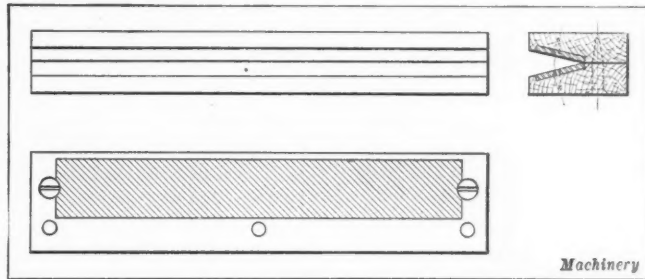
R. W. WILLIAMS

PENCIL SHARPENER

The average draftsman has occasion to use both conical and chisel shaped points on his pencils, and in order to get satisfactory results, the pencils must be sharpened at frequent intervals. The following describes a tool which enables pencils

blocking to raise the back end of the clamp. It will be seen that the device consists of an ordinary horseshoe clamp and a bolt fitting in one of the T-slots in the table; but instead of using blocks to support the outer end of the clamp, a small jack is substituted, making the device quickly adjustable to any height within the range of the screw. Reference

to be sharpened rapidly with either form of point. It consists of two ordinary hand files with the tangs broken off; slots are ground in each end of the files so that they may be held by screws, the files being held by two pieces of wood which are beveled in such a way that they may be joined at an angle. The files are screwed to these pieces of wood and the two pieces of wood are then screwed together. This pencil sharp-



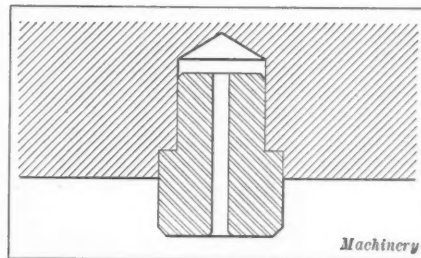
Pencil Sharpener for Drafting-room Use

ener is mounted in a vertical position where the draftsman can easily reach it; and by drawing the pencil down the groove formed by the two files the point may be renewed very rapidly.

C. C.

DESIGN OF JIG FEET

In the April number of MACHINERY, Donald Baker gives a method of putting in feet in a drill jig to avoid breakage and also to make their removal easy if this becomes necessary at any time. The writer has found that if the hole is counterbored as shown in the accompanying illustration, and the feet are sunk in a little below the surface of the casting, there is much less likelihood of breakage occurring because the foot is supported more strongly. The hole through the center of the foot is an excellent idea and can be applied to this style of foot as well as to that shown in Mr. Baker's article.



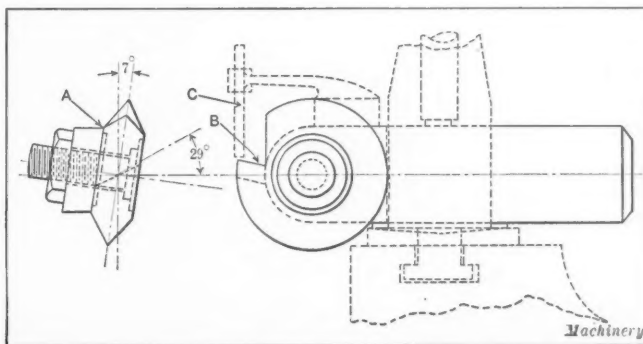
Design of Jig Feet

The hole through the center of the foot is an excellent idea and can be applied to this style of foot as well as to that shown in Mr. Baker's article.

A. A. D.

HIGH-PRODUCTION TURNING TOOL

The illustration shows a lathe tool designed to eliminate loss of time in setting, when turning duplicate work to micrometer dimensions. This tool must be set in the usual way for turning the first piece, and then, no matter how often it is reground, it is only necessary to replace it with the cutting edge set to a height gage to keep the dimensions of the work constant. It will be evident that since the radial distance from the center of the formed tool to the cutting edge will always remain the same, the cross-feed screw need not be moved; and if the cutting edge is accurately set for height,



High-production Turning Tool with Cutter bolted to Shank

the depth of cut can be kept accurate within about 0.002 inch.

The cutter is designed with a recessed face *A* in order that the bearing on the tool shank may be as large as possible, and thus prevent the cutter from turning under the thrust of the cut. At *B* is shown the method of using height gage *C* for resetting the cutter after grinding to bring the edge to the position that it formerly occupied.

Plainfield, N. J.

J. B. MURPHY

NUMBER OF TEETH IN END-MILLS

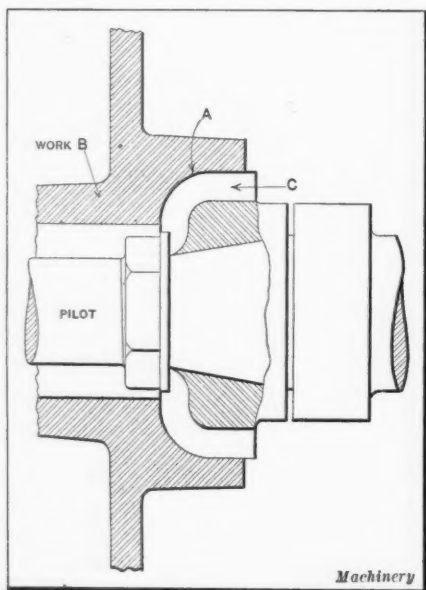
End-mills are frequently used for bottoming out holes or for similar work on turret lathes. Tools of this kind are necessarily fed in to the work by hand, by pressure on the spider wheel which controls the turret longitudinal feed. Considerable pressure is required to force a tool of this kind into the work and the number of teeth must be governed by the amount of surface which each tooth cuts.

Designers of tools frequently overlook this point and are inclined to make up the cutter as if for milling, with tooth spaces of $\frac{1}{2}$, $\frac{5}{8}$ or $\frac{3}{4}$ inch on the periphery. An end milling cutter, then, of 3 inches diameter with teeth $\frac{3}{4}$ inch apart might have, perhaps, twelve teeth. If the mill were designed for a form like that shown at *A* in the accompanying illustration in which the width of surface is about 1 inch, then all the teeth in the twelve-tooth mill would have $12 \times 1 = 12$ inches to cut, which would be equal to a forming cut 12 inches wide in the amount of pressure required.

The writer once tested out an equipment of tools under the conditions noted. The work *B* was held in chuck jaws on a turret lathe and the piloted end-mill *C* was fed into it by hand, using the spider wheel for the purpose. With the twelve-tooth mill mentioned, it was found impossible to use sufficient pressure to make it cut into the castings any appreciable amount, just a scraping action being apparent. It was difficult at first to see the reason for this trouble, but it seemed possible that too many teeth were in contact with the work.

Every other tooth was therefore ground away, leaving only six. After this, the mill cut much better, but still took much more pressure than seemed desirable. Three more teeth were then taken out, after which the mill cut very well, and without requiring excessive pressure.

It will be found advisable in designing end-mills for work such as that shown, not to put in too many teeth.



Work to be milled by End Milling Cutter

The total length of the teeth which are in contact with the work should not be more than 3 or 4 inches. If this idea is carried out, much better results will be obtained and the cutting qualities of the mill will be much improved. It will be found an improvement on face mills to nick the teeth in such a way that the nicks do not correspond on any two consecutive teeth. Recent developments along these lines favor the use of two-lip cutters for end cutting. These cutters are sometimes made of flat stock formed to shape and properly fixed in a holder.

A. A. D.

A CONVENIENT FORM OF TRIANGLE

The illustration presented herewith shows how the usefulness of a transparent triangle can be greatly increased. The

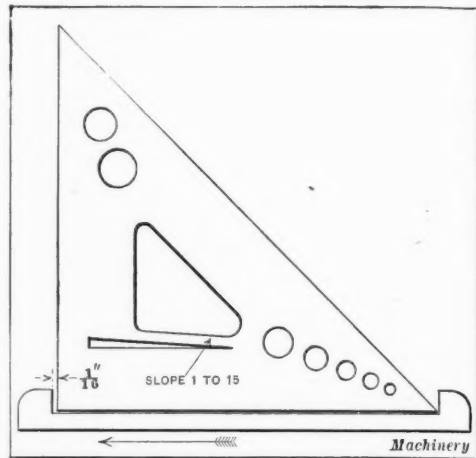
seven holes increase in size by intervals of $\frac{1}{16}$ inch, the smallest being $\frac{1}{8}$ inch in diameter, and are used for drawing fillets, rivet heads, or any small circles up to $\frac{1}{2}$ inch in diameter. Center lines may be scratched through the centers of the holes to aid in centering, but they are not necessary. Similarly, the size of each hole can be graven on the triangle, but since they are arranged in order, the sizes are easily remembered. It is unnecessary to turn the triangle in any way to get the holes into working position for drawing a fillet or a circle; and this device saves the time required to set the compasses and to locate the center of a desired arc or fillet. Furthermore, for the smallest sizes of circles, a clearer and better line is obtained than it is possible to get with the compasses. The pencil is slanted so as to draw the circle as large as possible. This insures a true circle. To drill the holes in the triangle, clamp the triangle to a flat piece of iron so that the bottom edge of the hole will not burr. Run the drill very slowly, as a small amount of heat will soften the celluloid sufficiently to produce an irregular hole. Use a drill $\frac{1}{64}$ inch larger than the nominal size of the hole; the circle that can be drawn will be about that much smaller than the hole.

To slant the edge of the inside opening of the triangle is a well-known contrivance for drawing the convention for screw threads, but I have never yet seen a published statement as to what the proper slant or slope should be. A slope of one in fifteen, equivalent to an angle of 3 degrees, 50 minutes, is just right for $\frac{5}{8}$ or $\frac{3}{4}$ inch U. S. standard bolts, and a close approximation for all sizes from $\frac{3}{8}$ inch to 2 inches. A good homemade device for cross-hatching is also shown. It is made about the thickness of the T-square and $\frac{1}{16}$ inch longer between jaws than the length of the edge of the triangle. Two different spacings may be obtained by rounding one corner of the triangle so that one edge will be $\frac{1}{16}$ inch shorter than the other. The larger spaces will be obtained when this shorter edge is in the cross-hatcher. In use, the cross-hatcher is placed against the edge of the T-square and the triangle against it, as shown. With the wrist resting on the blade of the T-square, one finger on the cross-hatcher and another on the triangle, slide the cross-hatcher and triangle alternately along the T-square in the direction of the arrow, drawing a line after each move.

The following describes a method of making erasures on tracings that I have found to work out very satisfactorily: Place a hard, smooth surface underneath the point at which it is necessary to make an erasure. A large amber triangle is just the thing for this purpose. Use a good grade of ink eraser, one that is entirely free from sand grains that cut the cloth. You will be surprised how cleanly you can erase in this way without roughening the cloth, even when the ink is on the dull side of the cloth. Yet this is only half the job. The cloth must now be resurfaced so that ink will not spread on it and so it will not absorb dirt at that point. With the triangle still underneath, glaze the cloth by smoothing it with the flat side of the blade of a large pocket-knife, applied with considerable pressure. It is best to have a knife that is dulled, and the point, and the corner on the blunt side, rounded so that the smoothing may be done rapidly with backward and forward strokes.

Connellsville, Pa.

E. V. KAPLAN



Triangle arranged for drawing Small Circles, indicating Screw Threads and cross-sectioning Drawings

SHARPENING AND RELIEVING HOBS

The following describes what I believe to be an improved method of sharpening hobs. Those who have had experience in this work know that it is difficult to sharpen hobs in which the gashes are at right angles to the threads and maintain accurate spacing of the gashes, unless a dividing head is employed. Fig. 1 shows a simple attachment for the tool grinder which is more convenient to use than the dividing head and enables accurate work to be done quite rapidly.

This attachment is fastened to the column of the grinder with cap-screws. The arrangement will be better understood by referring to Fig. 2, which shows the individual parts. The piece *A* is made of a piece of cold-rolled or machine steel, $\frac{1}{2}$ by $1\frac{1}{2}$ inch in size, which is bent to an angle of 90 degrees and twisted to the form shown; the elongated slots provide additional range. Piece *B* is made of the same material, and is fastened to *A* by means of bolt *C* and a nut and washer; the reamed hole at the end of piece *B* receives the shank of clamp *D*. This arrangement enables clamp *D* to be pivoted to any angle that may be desired, in which position it is secured by a nut and washer. The pin *E* is made of tool steel so that it may be hardened and ground to size. This pin is carried by clamp *D* and the tapered point is ground to an angle of 30 degrees to fit in the master on the arbor which supports the hob; pin *E* is secured in clamp *D* by a thumb-screw.

The arbor which supports the hob and master form is shown in the lower view, Fig. 2. The master is gashed at the same

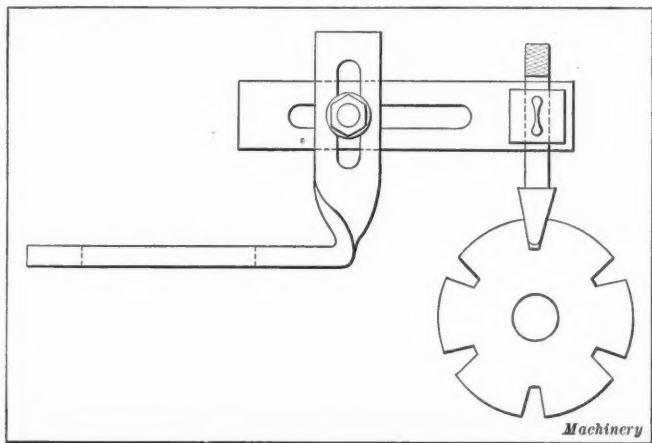


Fig. 1. Tool Grinder Attachment for use in grinding Hobs

time that the hob is gashed, and as a result the use of this fixture insures the maintenance of accurate spacing of the gashes in the hob. It will, of course, be evident that sufficient spacing collars are placed between the master and the hob to afford the necessary clearance for the grinding wheel. In making the master, the blank is turned to a diameter equal to the pitch diameter of the hob plus $\frac{1}{2}$ inch. The gashes are then milled to a depth of $\frac{1}{2}$ inch, using a cutter with an included angle of 30 degrees. The gashing of the hob is done with a cutter of the same angle. In grinding a hob, the master is mounted at one end of the arbor and the hob at the other, after which the arbor is set up on the centers of the grinder. The pin *E* enters the gashes in the master, which provides for obtaining the required rotation of the hob in addition to indexing the work to secure accurate spacing of the gashes.

In making hobs, I have sometimes been called upon to turn the work out as rapidly as possible in order to fill a rush order from a customer. As the relieving of the teeth is the part of the work which takes the greatest amount of time, this appeared to be the most likely place to look for possible improvements in the method of manufacture. In order to explain the improvement that I hit upon, let us assume that a hob is to be made for generating a worm $8\frac{1}{2}$ inches long with a normal pitch of 1 inch. We will make the hob 9 inches long and put nine gashes in it. For the purpose of discussion we will take three of these gashes and develop them into racks, as shown in Fig. 3. Here it will be seen that the lay-out is such that one tooth comes at the center of the hob, as shown in the top view. Now it is my contention that this center tooth is

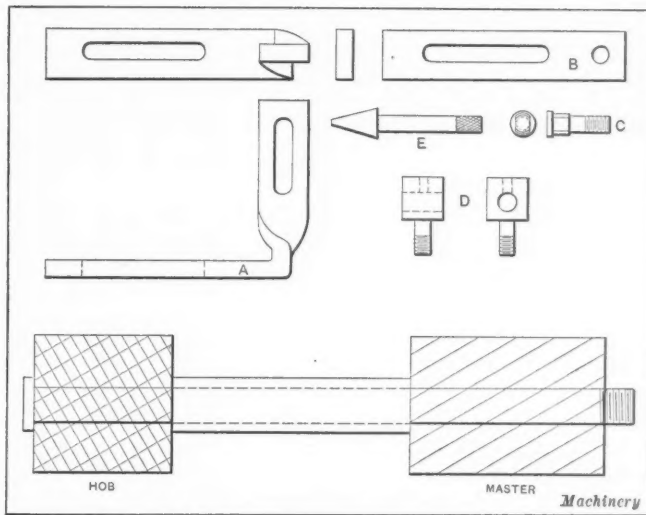


Fig. 2. Parts of Attachment shown in Fig. 1, and Hob and Master set up on Arbor

the only one which cuts on both sides, while the rest of the teeth only cut on the inner sides which have been marked by short arrows. Of course, it is impossible to have a center tooth produced by each of the gashes, and in the teeth produced by such gashes there will be two teeth at the center of the hob which will do a certain amount of cutting on both sides, this condition being shown in the two lower views in Fig. 3. Obviously, it is only necessary to relieve the sides of the teeth which take an active part in the generating action, and by following this method a material saving is effected in the amount of time required for relieving the teeth. This is particularly true in shops where the relieving is done by hand.

Springfield, Mass.

PAUL J. VISCO

DEPTH GAGE FOR A TAP

In tapping stud holes in cast iron, where it is desired to have the studs go in to a specified depth, the holes may be easily tapped to just the required depth by placing a check-nut on the tap to act as an indicator. When this kink is used the tap is run in until the nut comes almost into contact with the surface of the work at which point the machine is reversed. This does not give such satisfactory results in tapping steel, owing to the long curly chips produced.

Worcester, Mass.

C. H. ANDERSON

THE SQUARE CENTER

An article on the square center appeared on page 694 of the April number. We had occasion to make a 70-degree triangular center recently, and in calculating the proper angle to use in milling and grinding the triangular point, we discovered that there was an error in the figures given for the 60-degree triangular center in the article mentioned. Instead of being 26 degrees, 34 minutes, it should be 16 degrees, 6 minutes.

Galt, Ont.

CECIL H. SMITH

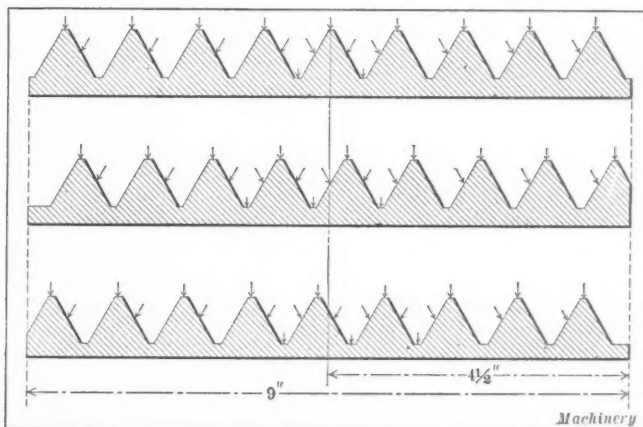


Fig. 3. Diagram showing Cutting Sides of Teeth of Hob, which must be relieved

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

NUMBER OF CUBIC INCHES IN BRITISH IMPERIAL GALLON

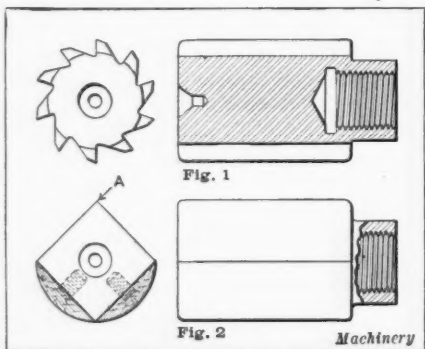
B. T. A.—Please inform me how many cubic inches are contained in the British imperial gallon.

A.—The legal definition of the British imperial gallon is: "The unit, or standard measure of capacity, from which all other measures of capacity, as well for liquids as for dry goods, shall be derived, shall be the gallon containing ten imperial standard pounds weight of distilled water, weighed in air against brass weights, with the water and air at 62 degrees F., and with the barometer at 30 inches. Letting w = the weight of a cubic foot of water under the above conditions, then, evidently, one gallon contains $\frac{1728 \times 10}{w}$ cubic inches. The main

difficulty is to determine the weight of a given volume of water. According to several authorities, $w = 62.355$ pounds; in which case, the gallon contains 277.123 cubic inches. The value almost universally used is 277.274 cubic inches. For many years, the Bureau International des Poids et Mesures, of Paris, has been conducting experiments to determine the density of water, and as a result of these determinations, the most reliable value for the imperial gallon has been computed to be 277.420 cubic inches. The present legal equivalent is fixed by an Order in Council, issued in 1889, as 277.463 cubic inches, but this does not seem to be generally known. J. J.

REBORING BRASS WORKING BARRELS

O. C. I. W.—Owing to trade conditions, it is impossible for us to get brass working barrels from the makers at present, and in order to take care of our trade in Louisiana, we must devise some method of repairing worn barrels that come to our shop. Will you kindly advise us what type of reamer to use in reboring these barrels in an engine lathe? The barrels are the cylinders of oil pumps used for pumping from oil wells, and range from 2 to 2½ inches in diameter and from 4 to 5 feet in length.



Figs. 1 and 2. Reamers for repairing Worn Working Barrels

enough to reach through the barrel, and did the work in a long lathe, the barrel being held in the chuck and supported in steadyrests. The coarse-pitch type of reamer commonly used is shown in Fig. 1. It had about ten teeth and was shaped on the leading and following ends about as shown. If we wanted a very nice job, we followed with a square reamer, packed up with wood, as shown in Fig. 2, to fill the barrel; the square edge A gave a scraping cut. This square reamer was used also when it was merely necessary to smooth out a worn barrel.

TO FIND A STRAIGHT LINE EQUAL IN LENGTH TO A GIVEN CIRCUMFERENCE

J. L. M.—Is there any easy and accurate method for finding geometrically a straight line equal in length to the circumference of a circle?

A.—There is, of course, no exact geometrical construction, and it has been proved that an exact construction is impossible. However, the following method is very rapid of execution and also very accurate.

Referring to the diagram, draw a diameter AB ; through one end B , draw a perpendicular line CD , which will, of course, be tangent to the circle at B . Through the center O , and with the aid of a 30-degree triangle, draw OC , making an angle of 30 degrees with AB , and intersecting CD in C . Then make CD equal to three times the radius OA , draw AD , and AD will be very nearly equal in length to one-half the circumference of the circle. The length of AD is readily calculated. Thus, letting the radius

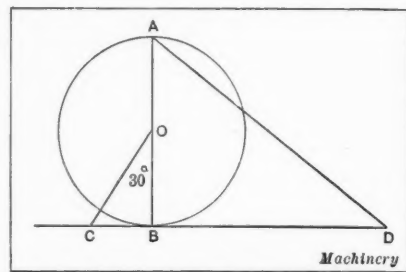


Diagram for constructing Line Equal in Length to Circumference of Circle

$= 1$, $BC = \tan 30 \text{ deg.} = \sqrt{\frac{1}{3}}$, and $BD = 3 - \sqrt{\frac{1}{3}}$; hence,

$$AD = \sqrt{2^2 + \left(3 - \sqrt{\frac{1}{3}}\right)^2} = 3.141533 +.$$

But, the semicircumference when the radius is 1 is $\pi = 3.141593$, and the difference between the two values is 0.00006, or a little less than

$\frac{2}{1000}$ of 1 per cent.

J. J.

ANALYSIS OF FORMULA FOR FINDING TAPER PER FOOT

W. W.—On page 898 of MACHINERY'S HANDBOOK there is a rule for finding the taper per foot when the center distance is given and the transverse measurements are taken at right angles to the line through the disk centers. Why is it necessary to find first the sine and then the tangent?

A.—Referring to the illustration, ba' is tangent to the two circles; gg' is the line through the centers; bo , ag , $b'o'$, and $a'g'$ are all perpendicular to og' . Then, letting t = taper per inch, $\frac{t}{2} = \frac{bo - b'o'}{C} = \frac{ag - a'g'}{C'}$. Of all the lines in these

two fractions, only C is known; hence, the numerator over C must be found by calculation. Draw cb' parallel to oo' and $bb'c = v$ = one-half the angle of taper. Let R = radius of large disk and r = radius of small disk. Draw $oa = R$ and $o'a' = r$ perpendicular to ba' ; then a and a' are the points of tangency. Draw oe parallel to $a'b$, and angle $ho'o = bb'c = v$. In triangle $o'eo$, $oe = R - r$ and $o'o = C$; hence, $\sin v = \frac{R - r}{C} = \frac{\frac{1}{2}D - \frac{1}{2}d}{C} = \frac{D - d}{2C}$, in

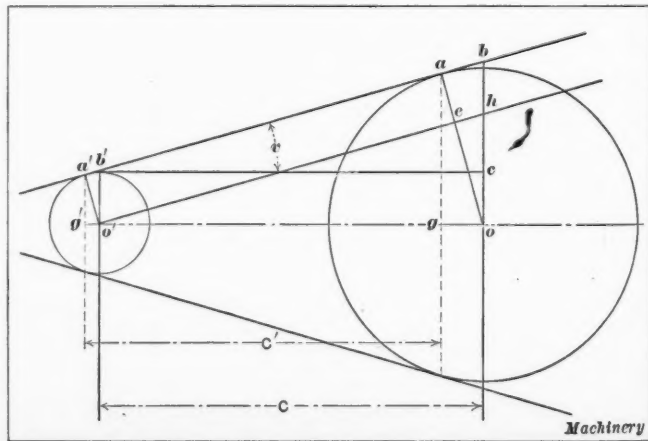


Diagram illustrating Formula for finding Taper per Foot

which D and d are the diameters of the disks. Knowing the sine, the angle can be found from a table of sines. Then, in the triangle $b'cb$, having a right angle at c , the angle v and the side $b'c$ are known, from which $cb = bo - b'o' = b'c \tan v = C \tan v$. Substituting this in the above expression for one-

half the taper, $\frac{t}{2} = \frac{C \tan v}{C} = \tan v$, or $t = 2 \tan v$. Letting

T be the taper per foot, $T = 12t = 12 \times 2 \tan v = 24 \tan v$, which agrees with the rule.

It is interesting to note that the second fraction above will give the same results, though a little more difficult to calculate, since C' is not known. For example, angle $gao = aob = v$, since ga and ob are perpendicular to $b'c$ and ao is perpendicular to $b'b$; for the same reason $g'a'o' = v$. Now $C' = o'o - go + g'o'$; but $go = ao \times \sin gao = R \sin v$, and $g'o' = r \sin v$; whence, $C' = C - R \sin v + r \sin v = C - (R - r) \sin v$. Similarly, $ag = R \cos v$, and $a'g' = r \cos v$; hence, $ag - a'g' =$

$(R - r) \cos v$. Consequently, $\frac{t}{2} = \frac{(R - r) \cos v}{C - (R - r) \sin v}$. It now

remains to be shown that the right-hand fraction is equal to $\tan v$. Dividing both numerator and denominator by $\cos v$,

the result is $\frac{R - r}{C \cos v} = \frac{oe}{o'e}$, since $R - r = oe$;

$\frac{C}{\cos v} = \frac{o'o}{\cos v} = o'h$; $(R - r) \tan v = oe \tan v = eh$; and

$o'h - eh = o'e$. But $\frac{oe}{o'e} = \tan v$; therefore, $\frac{t}{2} = \tan v$, and

$T = 24 \tan v$, as before.

J. J.

COMPARATIVE TESTS OF GAGES

A. A. L.—I have two gages on a wheel press with a $9\frac{1}{4}$ -inch ram; one is a Crosby recording gage indicating up to 200 tons on a $9\frac{1}{4}$ -inch ram, and the other an Ashton hydraulic gage registering up to 225 tons on a 9-inch ram. I also have a portable press with a 10-inch ram and a gage registering up to 250 tons, marked "tons on ram." Now suppose all three gages are connected to the wheel press with a $9\frac{1}{4}$ -inch ram and all register, say, 100 tons when pressing on the wheel. Does this agreement show that they are all correct? If not, please tell me how to make a comparative test.

A.—If all three gages register alike, say 100 tons, then at least two must be wrong, as a little consideration will show. These gages are not registering specific pressures (i. e., pounds or tons per square inch or per square foot), but total pressures. If a gage registering pounds per square inch were attached to one of the presses, the total pressure in pounds would be found by multiplying the cross-sectional area of the ram by the number of pounds per square inch indicated by the gage; this product divided by 2000 would be the number of tons, and should agree with the gage on the press, if both are accurate. It is evident that the smaller the ram the higher must be the specific pressure to get the same total pressure; hence, the total pressures are inversely proportional to the areas of the rams, or to the square of the diameters of the rams since the cross-sections are circles.

Let A denote the gage belonging to the press having the $9\frac{1}{4}$ -inch ram; B , the gage for the press having the 9-inch ram; and C , the gage for the press with the 10-inch ram. Then, if all three gages are attached to the press with the $9\frac{1}{4}$ -inch ram and gage A indicates 100 tons, gage B should indicate $9.25^2 \div 9^2 \times 100 = 105.6$ tons, and gage C should indicate $9.25^2 \div 10^2 \times 100 = 85.56$ tons, say 85.6 tons. If such be the case, we may safely assume that all three gages are correct. If, however, two of the gages register as calculated, we may assume that they are correct and the other one is wrong. That is, if gage B indicates 105.6 tons and gage C indicates, say, 84 tons, we assume that gages A and B are correct and gage C is wrong. If, however, neither gage B nor C indicates the proper value, but both indicate a greater or smaller pressure than that calculated, then increase the pressure until gage C indicates 100 tons. If gage B then indicates $10^2 \div 9^2 \times 100 = 123.45$ tons, say, 123.5 tons, we assume that gages B and C are correct and that gage A is wrong.

J. J.

LAW OF VIRTUAL VELOCITIES

M. G. D.—In an old textbook on mechanics, I frequently encounter the expression "principle of virtual velocities," but I do not find an adequate explanation of its meaning. It is to be used in some way in connection with the following problem:

With a system of pulleys arranged as in Fig. 1, what theoretical power P will be required to raise the weight W ? Will you please explain?

A.—The simplest statement of the law of virtual velocities is: The power multiplied by the distance through which it moves equals the weight multiplied by the distance through which it moves. Here the word "power" means the acting force, and the law applies to all machines. The reason

for using the word velocity instead of displacement (which is a better term) is that the older writers considered the time involved in the movement; but since the time the weight is moving is exactly equal to the time the power is acting, the time may be made unity and neglected, thus leaving the law as stated.

With reference to the problem, first consider Fig. 2. Here A is a movable pulley and B a fixed pulley. If the pulley A be lifted upward through a distance s , part a of the rope must be shortened an amount s and part b must be shortened the same amount, in order to keep the rope in contact with the pulley; in other words, a point or mark on the rope b will move upward a distance $2s$. Pulley B evidently exerts no influence other than to change the direction of the power from upward to downward. Hence, while W moves through a distance s , P moves through a distance $2s$. Now, according to the law of virtual velocities, $Ws = P \times 2s$, or $P = \frac{1}{2}W$, for the case of one movable pulley. In Fig. 1, if W be lifted a distance s , then, since pulley A is fixed, pulley B will descend a distance s ; and since pulley B is movable, pulley C will descend $2s$ in consequence of the descent of pulley B , and it will also descend an additional distance s by reason of the ascent of W through that distance. In other words, C descends $2s + s$. Similarly, D descends twice as far as C and through an additional distance s , or $2(2s + s) + s = 4s + 2s + s = (2^2 + 2 + 1)s$. The free end of the rope h , which corresponds to b or c in Fig. 2, descends twice as far as pulley D and an additional distance s , or $2(2^2 + 2 + 1)s + s = (2^3 + 2^2 + 2 + 1)s = 15s$. Consequently, when W moves through a distance s , P moves through a distance $15s$; hence, by the law of virtual velocities, $P \times 15s = Ws$, or $P = \frac{1}{15}W$. If $W = 1200$ pounds, $P = 1200 \div 15 = 80$ pounds, neglecting friction.

J. J.

PROBLEM IN DYNAMIC BALANCE

C. T.—I would like to obtain some definite information regarding a question which has been widely discussed in our

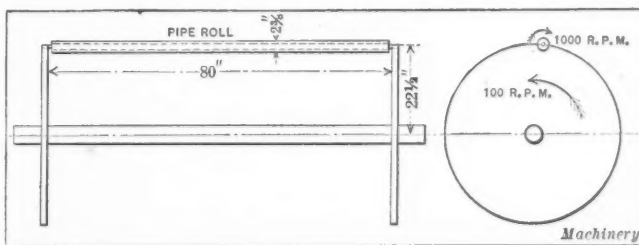


Diagram showing Arrangement of Mechanism which gave Trouble due to Lack of Accurate Dynamic Balance

factory, but concerning which no final decision has been reached. In a certain machine there is a member consisting of two large disks which rotate at 100 revolutions per minute in one direction and drive a number of shafts at 1000 revolutions per minute in the opposite direction. These shafts are made of pipe, and when the speed is increased beyond a certain limit, they show a tendency to "balloon" at the center, which causes serious trouble. Tests made by loading three different sizes of shafts with a dead load, while at rest, showed that the shaft made of the lightest pipe was deflected more than those made of heavier pipe, i. e., a pipe with walls 3/16 inch in thickness was deflected more than a pipe with walls 1/4 inch thick. What I wish to know is whether the results of the dead weight test give any indication of the probable action of the pipes when rotating; or will a pipe of heavier material deflect more than a light one, owing to the extra weight and action of centrifugal force? If the latter assumption is correct, can you explain the method of calculating the proper thickness of pipe wall which will enable it to resist deflection for a specified speed? The accompanying illustration shows the arrangement of the mechanism and indicates the directions of rotation and speed of the different members.

A.—You refer to trouble experienced from pipe rolls "ballooning" at the center and ask whether this is likely to be more serious with rolls made of heavy pipe than with rolls made of lighter pipe. We infer that this trouble is not caused by the actual swelling out of the pipe at the center, as the speed is not high enough to distort the pipe; moreover, if such distortion were of sufficient magnitude to be readily observed it would result in actually bursting the pipe. Your trouble is probably due to lack of perfect balance in the rolls and not to the action of centrifugal force. It is likely that the wall of the pipe you are using is not of uniform thickness, so that the axis does not pass through the center of gravity; in other words, the pipe is not in a condition of dynamic balance while rotating, although it may be in perfect static balance. Unless the wall of the pipe is of uniform thickness, it is quite possible that variations in the distribution of metal may result in a state of static balance, although the pipe will not approach a condition of balance when running at high speed. Under such conditions the pipe tends to rotate about an axis through its center of gravity, which will result in straining the bearings and springing the shaft. This is probably the cause of the "ballooning" to which you refer. For instance, a pipe or shaft may be in a condition of perfect static balance and still run badly through lack of dynamic balance. This is caused by having the pipe out of balance at one end and an equal amount out of balance at the other end, so that it tends to rotate about an axis through the center of gravity. The trouble could doubtless be overcome by using seamless steel tubing such as the Shelby tubing made by the National Tube Co. The walls of this tubing are perfectly uniform, and so it would be an easy matter to secure a condition of dynamic balance for rollers made from this material.

DRILL ROD GAGE SIZES

R. B. T.—The article by Fred Horner in the February, 1916, number, entitled "How Machinery Materials and Supplies are Sized," stated, under the subject of drill rods, that drill rods are sized by the Stub's steel wire gage or by the Morse twist drill gage. Now these two gages differ, and the writer would like to know which in your opinion is used most in this country.

A.—Drill rod is made by the manufacturers to the Stub's steel wire gage. But in manufacturing establishments it is common practice for toolmakers and others to call for drill rod to agree with the Morse twist drill gage. This is possible because the differences between the Stub's gage and the Morse gage are in many cases only a thousandth or a fraction of a thousandth inch, and certain numbers of the Morse gage agree with numbers in the Stub's gage. For example, No. 6 Morse gage is the same as No. 5 Stub's steel wire gage; No. 11 Morse is the same as No. 10 Stub's; No. 15 Morse is the same as No. 14 Stub's; No. 20 gage Morse is the same as No. 20 Stub's; and so on. However, the best practice to follow when ordering drill rod is to order the sizes in thousandths inch. Then there can be no mistake. This practice should be followed both in ordering drill rod from the drill rod manufacturers and from the store-room in the shop. Reference to gages is bad practice and leads to mistakes and confusion. The confu-

sion of gages generally is deplorable, and mechanics should avoid taking risks in ordering any material when the diameter or thickness can be expressed in thousandths inch.

LIMITS OF DRILL ROD AND SHEET STEEL

C. L. K.—What are the allowable variations in the diameter of drill rods and the thickness of sheet steel cold-rolled?

A.—The Navy Department specifies that drill rods may have a variation of 0.0005 inch on sizes 7/16 inch diameter or less, and 0.001 inch on sizes larger than 7/16 inch. These are the maximum variations allowed. The Navy Department also permits variations of 0.003 inch on cold-rolled or cold-drawn machinery steel rods and bars up to and including 1 inch. Above 1 inch and including 2 1/2 inches, the allowable variation is 0.004 inch, and above 2 1/2 inches, 0.005 inch. The Halcomb Steel Co., Syracuse, N. Y., manufacturer of drill rods, advises that all sizes of drill rods produced up to 1 1/2 inch round, which is the largest size on the list, are within 0.0005 inch above or below the specified size or decimal size. It is willing to guarantee that on all sizes less than 1 inch, the limit above or below will be 0.00035 inch of the specified size. On cold-rolled strip steel, the Worcester Steel Co., Worcester, Mass., allows the following variations: from 0.025 inch to 0.100 inch in thickness, ± 0.0015 inch; from 0.100 inch to 0.200 inch in thickness, ± 0.0025 inch; and from 0.200 inch to 0.275 inch in thickness, ± 0.0035 inch. The General Electric specifications call for the following: up to and including 0.3 inch diameter drill rods, over size 0.000, under size 1 per cent of the diameter, eccentricity 1/2 per cent of the diameter; above 0.3 inch and including 1 inch, over size 0.000, under size 0.003 inch, eccentricity 0.0015 inch; above 1 inch and including 2 1/2 inches, over size 0.000, under size 0.004 inch, eccentricity 0.002 inch; above 2 1/2 inches, over size 0.000, under size 0.005 inch, eccentricity 0.0025 inch. The A. O. Smith Co., Milwaukee, Wis., manufacturer of automobile parts and steel stampings, uses a great deal of blue annealed steel. The limits of variation allowed on this grade of steel are 0.005 inch under or over the specified gage. The Westinghouse companies permit the variations of cold-rolled steel specified by the American Society for Testing Materials, but have a number of different allowances for different applications. The Brown & Sharpe Mfg. Co. states that all the drill rod used passes an inspection and is accepted with a variation of 0.0005 inch large or small. In cold-rolled or drawn machinery steel, the limits vary from 0.001 to 0.005 inch, depending on where the stock is to be used.

* * *

Manufacturing industries of the United States are growing at a rate that has resulted in doubling the output of manufactured products since 1900. The aggregate value of manufactured products in 1915 was \$24,000,000,000, and in 1900 it was only \$12,000,000,000. The production value in 1910 was \$20,500,000,000, and only \$14,750,000,000 in 1905. Up to the outbreak of the present war, the United States was rated third as an exporter of manufactured products, Great Britain being first, Germany second, and France fourth. The British total in annual value was about \$2,000,000,000 more than that of the United States, and Germany's about \$1,500,000,000 more. The growth in percentages is also interesting. In 1890 the manufactured products exported were 25 per cent of the total manufactured; in 1910, 45 per cent; in 1913, 47 per cent; and in 1915, more than 51 per cent.

* * *

Although the manufacture of pistons and piston rings used in steam and gas engines has been developed to a high plane since the manufacture of automobiles began on a large scale, there is much to be learned about piston ring design and the best method of making the so-called leakless type. What constitutes a perfect piston ring? How should it be fitted in the groove? What pressure should a ring exert against the cylinder wall when in position? What should be the relation of the piston ring to its groove? Is the eccentric type desirable? If not, why not? These and other questions can be profitably discussed, and readers of MACHINERY are invited to take part.

PREPAREDNESS IN MANUFACTURE

RESULTS OF LACK OF PRELIMINARY PLANNING IN A MUNITIONS PLANT

BY J. J. R.

DURING the past few months a number of manufacturers have taken up lines of work in connection with munitions with which they were entirely unfamiliar and the requirements of which were very exacting as compared to many other lines of manufacturing work. In many cases work has been produced and carried through on a large scale only to find that when completed it did not fulfill the requirements of the government inspectors, so that many parts were rejected for a variety of reasons. In the majority of cases of this kind, the reason for rejection can be traced directly back to a lack of knowledge on the part of the manufacturer, together with a lack of preparation for the work in the preliminary planning as well as in the design of the tools and gages. This article will take up such conditions as are illustrated in the manufacture of bayonets, giving a general account of the organization and processes, together with the equipment used and a statement concerning many of the points which were responsible for the failure to produce satisfactory work.

The severity of government inspection, as applied to military equipment, has never before been realized to such an extent by manufacturers, and for this reason a large proportion of the material offered for acceptance was found to be below the standard, with the result that severe financial losses were entailed. In some cases, better results have only been obtained by radical changes in methods of manufacture, and this also has caused a delay in delivery and heavy financial losses, many orders having been executed at an actual loss where the profits should have been great if the work had been properly handled. Some of the troubles which have been experienced by one company in the manufacture of bayonets will be taken up in detail in this article and an attempt will be made to show how the lack of knowledge and proper planning caused the failure.

Data Given to Manufacturers

In the case of bayonets to be manufactured, samples of hardened, semi-finished blades were received by the contractors, together with sealed patterns of bayonets having the government certification that they were standard and met all requirements. Complete drawings of the bayonet itself were also furnished. Inspectors having years of experience at that work in government arsenals were sent over to take charge of the final acceptance. Drawings of machines used in testing were furnished and each inspector had a full set of drawings and gages.

Data Not Given

There was no indication of manufacturing methods which had previously proved successful and no hint was given where trouble had been found; no suggestions for the design of working gages; no assistance in supervising and no suggestions for final acceptance gages. The drawing of the bayonet was absolutely correct and any blade which was made to conform to the drawing would fit the gages.

Shop Organization

The organization as planned by the contractors was to be composed of men who had made military rifles for years and bayonets by the hundreds of thousands. It consisted of men who had also had years of experience in government and private work, each of which was a specialist in his own line. Practical mechanics of proved ability were chosen who in many instances had worked together before. None of the men, however, had previously handled manufacturing matters on a large scale or had worked as heads of departments. The supply of money for the purchase of equipment was unlimited, and it simply remained for the specialists to indicate the classes of machines which were needed and the purchasing department would immediately negotiate for the equipment. In each department the specialists had charge in a large way of the design of everything in the department but had not had

previous experience in designing. First quality material was bought in all cases and the quantity needed was determined upon by the head of the department.

The general idea in taking up this work, was to use the bayonet job as a sort of experimental center around which an organization would be built which could handle the more complicated military rifle problems to the best advantage. In conference, a scheme of manufacture was laid out and manufacturers from different parts of the country gave every assistance in suggesting methods and equipment. Orders were given for machine tools, jigs and fixtures, the design of which was directly under the supervision of the specialists. The factory buildings were built by outside contractors working on a percentage basis and with a time limit on the completion of the work. After the essential points in the buildings and machine shop equipment had been taken care of, young technical graduates who could be trained were installed as inspectors and were detailed to the various shops to watch the progress of the orders.

Bayonet forgings were ordered from outside manufacturers in sufficient quantities so that the machining operations could be started as soon as the machines were installed, which was scheduled for a month before the first delivery was due. Men were appointed to oversee the forging operations, make preliminary tests, standardize hardening of the bayonet and take care of the incoming machinery. After the organization was complete for the bayonet department, preparations were started for the manufacture of the military rifle itself, as it was considered that the organization was complete for the bayonet and everything seemed to be running along smoothly. The essential requirements in the handling of this problem were that the production should be accomplished in the shortest possible time, and it should be remembered in this connection that the problems as presented were entirely new. A general scheme of manufacture was laid out and rough sketches were made of the jigs and fixtures necessary; working time was estimated, and types and quantities of machines were computed and ordered. There was no supervision nor assistance furnished by the purchasing government, and although it would have taken only a short time to have inspected methods and conditions in the arsenals where the work was being done, this point was not considered. Neither did it occur to the executives to submit samples of various grades of steels for manufacture in the aforesaid arsenals so that tests as to their suitability could be made after they had been carried through the various processes. It must be assumed that the executives considered that any such precautions as this must have reflected on American mechanics, methods and materials, and although these matters might have been easily taken up, before the actual manufacturing commenced in this country, it was not done.

Preliminary Test of Hardening Method

At an early stage in the manufacture, it was realized that the tests for physical condition of the bayonet were more severe than had been used in this country, so that preliminary tests were roughly carried out with drop-forged unfinished blades, seemingly with satisfactory results. Records were made of hardening and drawing temperatures and the matter was considered settled. Representatives of the steel companies furnishing the steels were present at the time of testing, but no finished blades were ever tested before manufacture in quantity was commenced. On the basis of a rough test of hand forged blades a large quantity of steel was bought, and after a second test still more steel was ordered.

Method of Manufacture

The fundamental point in the method of manufacture of the bayonet was to take advantage of the supposed superiority of drop-forging in this country and to forge the blade so that 0.010 inch would be allowed for finish on each side. It was

planned to reduce the actual machining operations to a minimum, employing grinding operations instead. For this reason the drop-forging dies were made with the greatest care.

A steel having the carbon content of a military bayonet is extremely sensitive to high temperatures and loses the carbon on the surface rapidly. Some of the blades which were put through at this time showed decarbonization after being finished for over 1/32 inch depth all over. It was found necessary to keep the drop-forging heats very low or the blade would be ruined. Owing to the fact that there was not sufficient metal on the original forgings to allow for decarbonization, thousands of the bayonets were "scrapped." It was finally found necessary to change the drop-forging dies so as to allow for a finish of about 0.060 inch, at the same time making the back of the blade very full and then milling instead of grinding it. The allowance for grinding on the point was also increased.

When the forgings were ready and the machinery came in, some of the operations on the bayonet were started. Machines were received with jigs attached and in many cases no work was necessary except to connect the machines with the countershaft. Men were put to work on the various machines and taught just how the machines should be handled.

About this time the trouble commenced. In many cases the jigs were sketched originally on scraps of paper and were later detailed by men who had never seen the parts for which the jig was intended. Drawings were not checked in some instances, so that after the tools were finished they were incorrect. The locating points were not properly placed and sometimes there was no provision at all for locating the work. Some of the operations as planned which appeared reasonable on a superficial examination were afterward found impossible or undesirable for some reason or other. The new mechanics, who were mere machine tenders, were not skillful enough to make the required changes. As the time of first delivery approached, a notice was sent to the original groups of executives and a meeting was held, in order to straighten out the tangle if possible. In the meantime the rifle production planning, the buying of new machinery, the designing of new tools, and so forth, was allowed to take care of itself. During this time, many of the soft-handed ex-machinists worked day and night in making over gages and testing jigs until finally the various machines were started in operation in one way or another. No records were made of the changes, however, and the drawings still showed the fixtures as they were originally.

There was no toolroom which could be called such, although there were a lathe, drill press, tool and cutter grinder and a shaper. There were no small tools of any account and not a real toolmaker in the toolroom. This was for a shop having a capacity of 600 men! Just about this time, after the fixture troubles had been straightened out, more difficulties appeared in the hardening room. The furnaces for heating the bayonets were too short; the tempering pots were too shallow, and temperatures could not be regulated properly because of lack of proper instruments for temperature measuring. The cooling tanks were too shallow and of insufficient size, while only one experienced hardener was available.

As the organization increased in numbers, politics and interfering authority began to take a hand in the management. In the course of three weeks, seven different men were put in charge of and removed from the hardening room. Finally steel experts from three different companies were called in and many kinds of steels were tried before the final choice was made of an expensive alloy steel. Even after the selection of this stock, but one out of two bayonets passed the test for some months. The blame was thrown on outside manufacturers for the choice of materials, and methods and errors were covered over and buried wherever possible. Good men who were not in the clique were discharged or forced out of the organization.

Local purchasing was personally done by a responsible head with no understudy, and many thousands were spent without a thought, while small items were held up and haggled over for days while men waited for the material. Available assistance was not used to help matters along, and in one case

technical graduates having from three to seven years' experience were kept inspecting guide and catch sizes for weeks, while experienced heads neglected big matters to attend to minor details. New men were appointed as heads of departments and more cliques were formed. Workmen were paid as little as possible, thus causing dissatisfaction and creating a likelihood of a strike in the future. The discipline around the plant was almost military, and finally when the strikes came, "German bribery" was assigned as a reason. The final result of the many mistakes in the organization and management can be found in the fact that some weeks after the production should have reached 1000 per day, not one bayonet had been accepted. Even months after the production should have reached several thousands per day, not 500 per day were coming through the works, and a year after the contract was started the desired production had not yet been reached.

The severity of the specifications was not entirely responsible for this, as the rifle itself was one of the crudest of the modern arms in use. The facts are as follows: The order was in hand February 1 and machinery was being delivered during April. In December, 18,000 pieces of one part were scrapped, because they were 1/16 inch under size. The government gages were in the possession of the factory in March and delivery was to be started in August. Owing to the many troubles experienced and the lack of preliminary planning, together with improper organization, it does not now seem probable that the full production will be reached before the fall of this year.

It may be argued that the instance stated is exaggerated, but this can be easily refuted by an investigation. It will be found that a somewhat similar condition has existed in many plants, although not always to the same extent as that stated. Manufacturers of jigs and fixtures throughout the country have shipped complete series of tools to various factories and have later received revised drawings, necessitating building a new series before the first equipment was received by the factory. In these cases fundamental errors in design were discovered.

There is a valuable lesson to be learned from the experiences of the company cited in this article, and that is, the extreme importance of preliminary planning. The motto "Make haste slowly," seems particularly applicable to work of this kind. Unless the planning is done in advance and is carried out to the most minute details, any organization of this sort is likely to meet with disaster.

* * *

POLISHING OPERATIONS

Polishing operations on metals are usually known as roughing, dry fining and finishing or oiling. The abrasives used for roughing usually run from No. 20 to No. 80, for dry fining from No. 90 to No. 120, for finishing, from No. 150 to No. 65 F. For the first two operations—roughing out and dry fining—the polishing wheel should be used dry. For finishing, the wheels are first worn down a little and then tallow, oil, beeswax and similar substances are used on the wheel. This third operation is sometimes known as greasing. Sufficiently good finish is frequently secured by the dry fining operation when the wheel is covered with charcoal and smoothed down with a piece of flint. Most polishers keep a lump of pumice stone handy to clean the greased wheel or remove the glaze from finished wheels.—*Grits and Grinds.*

* * *

An ordinary hand-operated arbor press can often be used in the job shop as a punch press when a number of simple punchings are required. In order that the arbor press may be utilized as a punch press, it is necessary to provide a simple sub-press provided with the required punch and die. The sub-press is put in place in the arbor press and worked by bringing the ram down against the ram of the sub-press. The springs raise the sub-press ram, following up the ram of the press on the return stroke. With this equipment it is possible for an ordinary job shop to produce simple punchings at a comparatively low labor cost and with a very small investment in tools.

INTERNATIONAL TRADE CONDITIONS

MANUFACTURING IN THE COUNTRIES AT WAR—SOUTH AMERICAN RELATIONS

MANY people are asking: What will be the status of the United States after the war? Some think it will retain its present commercial supremacy, while others think it will again allow England and Germany to dominate the markets of the world. But the post war status of the United States will depend almost as much on matters over which it has no control as on its actions at this time.

England owes much of its commercial supremacy to the fact that during the reign of anarchy throughout Europe at the beginning of the last century, every nation was dependent on the factories of England for its supplies. While at present the entire world is buying supplies from this nation, it is not because of the destruction of the factories of the other countries and their lack of skilled workmen, but rather because of the abnormal demand for some things and conditions that make it, temporarily, impossible for these countries to make those articles. But just as soon as peace is restored there will be available in all countries well equipped factories fully manned with skilled workmen. The equipment and methods of these factories are most efficient, so that one of the reputed advantages of the American factories has been lost. How great has been this increased efficiency is shown by the fact that in one case, though an extreme one, the hourly output of a British machine was increased from eight or twelve to ninety pieces. Besides, the American manufacturer will hereafter have to compete with those able to employ large numbers of women. In Great Britain over two million women are employed in industries that formerly employed only men. While women have not entered as many new industries in France and the other belligerent countries, it is because they have always done work that in the United States and Great Britain has been considered fit occupation for men only. Edward R. Stettinius, chief of the export department of J. P. Morgan & Co., said recently: "Most of the reconstruction of the European countries now at war will be done by themselves when the war is ended. Many of the large factories that have sprung up for the production of war munitions will be utilized for other purposes when the war is over; besides, many of the men returning from the front will have to be given employment."

Contrary to the general opinion, and many reports, the belligerent countries are not rapidly becoming impoverished. While Germany has not been able to send its products freely to the outside world, before the British Orders in Council went into effect a year ago its exports to the United States were \$10,000,000 a month. During the last half of 1915, it sent to the United States a little over \$2,000,000 worth of toys; \$1,000,000 each of leather goods and chinaware; \$500,000 each of laces, paper and raw skins; \$200,000 of furs; \$250,000 of photographic papers; \$120,000 of musical instruments; \$241,000 of gelatine; \$160,000 of glassware; \$133,000 of knit goods; \$125,000 of clocks; \$29,000 of books; \$10,000 of post cards; \$116,000 of chemicals and drugs. Germany's shipments to this country still amount to \$1,000,000 a month.

While all limited companies, mining companies, etc., must pay a war tax of 50 per cent of the additional profits earned during the war, 1000 of the 6500 companies paid this tax; the average tax for fifty-three of these companies was 650,000 marks. The Rhenish Metal Ware Co. paid a tax of 5,300,000 marks; besides, from its net profits of 9,876,619 marks, against 3,524,439 marks in 1914, it invested 2,605,876 marks in securities, principally war loans, and raised the wages of its employees from 5.22 to 5.8 marks per man per shift. It also increased the number of its employees from 14,414 to 24,000. The Hirsch Copper & Brass Works paid a war tax of 4,000,000 marks; besides, it paid a dividend of 18 per cent, against a dividend of 8 per cent for the past three years. It also wrote off 1,490,539 marks for depreciation. The Adler-Oppenheim Leather Co. paid a tax of 3,000,000 marks; the Thale Iron Works, a tax of 1,900,000 marks; and the Rheydt Electro-

chemical Co. a tax of 1,850,000 marks, its net profits being 3,580,592 marks, against 385,635 marks in 1914. The Gas Apparatus & Gas Works Co., of Mayence, which has a capital of 1,080,000 marks, had a net profit of 3,636,547 marks, against 33,985 marks in 1914; besides paying a war tax of 1,800,000 marks, it declared a dividend of 125 per cent and invested 2,879,661 marks in the war loans. The average dividends of 118 of the leading raw sugar manufacturers was 13.6 per cent, against 8.3 per cent in the preceding year; this is the largest dividend yet paid in this industry. The Rhenish Tannery Goods Co., of Benrath, paid a war tax of 200,000 marks and a dividend of 25 per cent, against 16 per cent last year. The Wiemann Leather Co. paid a tax of 1,400,000 marks; the Neckar Ulmer Cycle Co., 2,000,000 marks; the Wanderer Cycle Co., 1,000,000 marks; and the Durkopp Cycle Co., 1,000,000 marks. The Harzer Works at Rubeland-Zorge has raised its dividend from 6 to 25 per cent and paid a war tax of 425,000 marks. Hugo Schneider Co. Metal & Brass Works, Leipsic, declared a 20 per cent dividend, against a 6 per cent dividend in 1914. The Upper Silesian Railway Metal Co. paid a 10 per cent dividend, against 2 per cent in 1914. The Niederschone-weide Works, which began business in 1914, paid a 16 per cent dividend and a bonus of 84 per cent; while the Magdeburg Machine Tool Co., which also began business in 1914, paid a 15 per cent dividend. This spring, the builders in the smaller towns voluntarily raised the wages of their men; while the government, because of the enormous profits made by the agrarian interests, nearly doubled the rentals of seven of its large estates in Prussia. If Great Britain will permit the delivery of the 15,000 tons of dyes contracted for, Germany will have in this country an addition to its trading balance here of \$90,000,000.

That Germany is still intent on seeking all the commerce possible is shown by the statement of the Koch Shipbuilding Co., of Lubeck, at its stockholders' meeting, that it had enough orders to keep its yards, which will build ships up to 15,000 tons, busy for several years. Over 1500 persons are now enrolled in the Turkish classes recently established by the German Turkish Society in thirty German towns. The forty-mile pipe line that has just been built between Drohobycz and Chyrow, in Galicia, will admit of the movement of about 700 tons of oil daily. The number of German salesmen that went to Bergen and Molde, Norway, after the large fires there was so large that the Norwegian railways had to double the size of its trains.

Germany is constantly seeking new trade in South America, as the feeling of the people is expressed by Count Reventlow, when he says:

The economic side of the present war is closely related to the military and political aspects of it, more so than at any previous period. After this war a state that cannot make sure of its economic future by its own unaided strength will practically be condemned to extinction. Laden with a huge burden of debt, with keener conditions of life, and with the necessity of providing for their military security, the countries concerned will not be able to export too great a quantity of commodities. It is therefore all the more necessary for Germany, too, to make certain that she shall secure the most stringent guarantees for the free exercise of every sphere of her economic life.

Germany is especially interested in Turkish chrome mining, for which sixty charters have been granted. The Krupps have purchased two of these mines and are operating two others. Besides, seventy charters have been granted for lead mining, one of which will supply the entire German demand.

Notwithstanding the enormous army France has in the field, on May 7, the canal connecting Marseilles with the Rhone, and thus giving it direct water connection with Havre and the North Sea, was officially opened. Though this canal is only sixty miles long, five miles of it is a tunnel 75 feet wide and 70 feet high, placing this among the largest tunnels in the world. As the canal is navigable to vessels less than 600 tons,

destroyers and small warcraft can pass through it from the Mediterranean to the North Sea. Also, in order that France will lose none of its commerce, on May 18 President Poincaré signed a decree creating a committee to aid in the reconstruction of towns and regions invaded and affected by acts of war. A large number of the textile factories in the invaded regions are now being operated in the southern part of the country; it is doubtful if some of them will again return to their former towns. During April, France exported 33,500,000 francs worth of goods more than in the same month last year.

England's exports have not decreased except in some things. The advantage its merchant marine gives it in trade is shown in the fact that British ships have recently secured contracts for iron and steel products from South American countries, because of the difference in freight rates. On one inquiry from Rio Janeiro, a rate of \$40 a ton was quoted from Gulf of Mexico ports, while the freight rate from British ports was only \$14 to \$15 a ton. Due chiefly to the diversion of trade by the British blockade, the exports from the Port of London to the United States during the first four months of this year were \$13,000,000 more than for the corresponding period last year. According to the Board of Trade returns, the exports from England for April showed an increase of \$23,240,000.

B. M. Rasmussen, U. S. Consul at Gothenburg, Sweden, recently said, in the *Swedish-American Trade Journal*, that, owing to the lack of transportation facilities, high rate of exchange, and economic depression in Russia, the export of agricultural machinery, petroleum motors, and telephone instruments from Sweden to that country decreased to such an extent that industrial concerns depending on such markets found it necessary to retrench. While war orders were abundant in the latter part of last year, a lack of raw material, especially aluminum, copper, lead, tin, celluloid, emery, hardwoods, leather belting, oils, rubber, etc., interfered with the production of the factories. The lack of coal also added to the increased cost of production for many, but in most cases manufacturers have been able to meet the advanced costs by advanced prices. As the freight rate on coal is now twice as much as the total cost of coal, including the insurance and freight, to the Swedish railways, in 1914, plans are being made to utilize the water power of the country to the fullest possible extent, though about 50 per cent of all manufactured products are now made in factories using this power.

Stanley H. Rose, agent in charge of the New York office of the Bureau of Foreign and Domestic Commerce, says that investigation shows that between \$50,000,000 and \$60,000,000 worth of Russian raw products could be used here annually. Owing to the closing of the Baltic and Black Sea ports, however, the Russian Government has been forced to restrict the use of the White Sea so that no vessel can load or unload there without a special permit. This rule applies to all vessels, irrespective of whether they are carrying goods for the government or not. Application for space must be made to the Russian Commercial attaché, Mr. Medzikhovsky, who cables the request to London and Petrograd and then reports to the shipper the probable date of shipment. This restriction, though, does not apply to the Pacific ports. Recently it was estimated that nearly \$10,000,000 worth of goods were awaiting release from the government, for which only \$1,500,000 worth had been passed upon, and of these only \$400,000 worth had been received in this country.

In a letter to Edward N. Hurley, vice-chairman of the Federal Trade Commission, President Wilson said: "If we are to be an independent factor in the world's markets, we must be more thorough and efficient in production. The encouragement of trade associations and standardization in better cost-accounting methods in our business concerns will go a long way toward accomplishing this end."

Paul M. Warburg, of the Federal Reserve Board, on his return from the Pan-American Conference at Buenos Aires, was enthusiastic over the progress apparent in the strengthening of the commercial financial relations between the United States and the South and Central American republics. He regards the experience of the Latin-American business world

during the European war as calculated to cement commercial relations with the United States, but says that if this nation is to secure its proper position in the world all legislative obstructions that stand in the way of a free unfolding of its economic powers must be removed. Some of the countries visited, he said, had to solve difficult problems due to or accentuated by the European war. But these problems had produced men whose sincerity and ability foster a perfect reliance that their country's fate is in good hands and will ultimately be worked out successfully. He also said that almost all of these countries offer wonderful possibilities and the United States has a serious obligation to lend a helping hand to them in the development of their marvelous resources. There is, however, strong evidence of the awakening of the American spirit of enterprise in almost all of these countries; whether in railroading and developing the ore lands in Brazil, in packing houses in Uruguay and Argentina, in mining in Chile and Peru, or in raising sugar and tobacco in Cuba.

Plans have been completed for the construction on some point of Long Island or the Connecticut shore of the highest tower in the world to be used by the Federal Holdings Co. in wireless communication with a tower near Buenos Aires, for which a concession has been obtained from Argentine. Efforts are being made to obtain concessions for similar towers in Brazil, Uruguay, and other places in South America. In addition to its war value, intercontinental wireless will be of great value in the campaign for South American trade, besides its importance in the direct exchange of news. As the cable rate from New York to Buenos Aires is 85 cents a word, the papers of Buenos Aires at present are the only ones in South America that print much news from the United States. Besides making a rate at least one-third of this, the wireless will permit the transmission of independent news, for now the news received in South American countries goes very largely over lines controlled by the trade rivals of America. It has therefore been asserted that one reason for the poor opinion of the United States held by many South Americans has been that news has received an unfriendly color in its transmission through European hands to the South American press.

Because of the lack of shipping facilities for the manufactured articles, orders have been placed in the United States for the equipment for a complete shoe factory in Colombia, for the manufacturing of fencing, telephone and telegraph wire, and tinware in Brazil, and a nail factory in Argentina. Robert Lee Dunn, secretary of the All-Americas Association, says that the people of Central America want to do their foreign business in the United States and are willing to trade on a cash basis. There has been deposited with his organization since January 1, to be drawn against, almost \$500,000 in gold, besides millions of dollars of negotiable paper by buyers in South and Central America.

In accordance with its policy to aid American countries in all parts of the world, the National City Bank, of New York, has arranged to open a branch in Genoa, Italy, which will be under the direction of Paul Grosjean. Arrangements are also being made for the opening of banks in Russia, Spain, and the Scandinavian countries. D. E. J.

* * *

The motor truck has proved its worth as a means for rapidly conveying troops and supplies in the European war, and the U. S. government is making use of motor trucks with advantage in quelling the Mexican trouble. An unusual order for trucks was placed in May with the Locomobile Co. of America by the government for thirty three-ton Riker trucks. These trucks are fitted with a flanged rim device developed by A. L. Riker, vice-president and chief engineer of the Locomobile Co. of America, by which the trucks are converted into railway motor cars. One of the trucks ran from Columbus, N. M., to El Paso, Texas, over the rails of the El Paso & Southwestern Ry. System, a distance of ninety-three miles at the rate of nineteen miles an hour, carrying twenty soldiers with complete equipment. When the end of the run was reached, the truck was derailed, the flanged rims removed, and the truck was then ready to be driven on a highway as usual.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

NATIONAL MANUFACTURING MILLING MACHINE

This machine is intended for manufacturing operations, and it will be seen that the design includes features of both the Lincoln and knee types of milling machines. The machine may be equipped for individual motor drive, with a cone pulley for driving from a countershaft, or with a single pulley and geared drive. Eight changes of feed are provided, ranging from 0.007 to 0.202 inch per revolution. With the three-step cone pulley and two-speed countershaft, there are twelve changes of speed ranging from 16 to 224 revolutions per minute.

The design of the No. 6 manufacturing milling machine which has recently been placed on the market by the National Transit Pump & Machine Co., Oil City, Pa., has been developed along lines which enable certain features of the Lincoln type of milling machine and the knee type of milling machine to be combined. Two views of the machine are shown in Figs. 1 and 2, and it will be evident from these illustrations that the vertical position of the table remains constant, and as it is carried on a fixed support, ample strength may be easily provided; combined with this feature is the fact that the open-

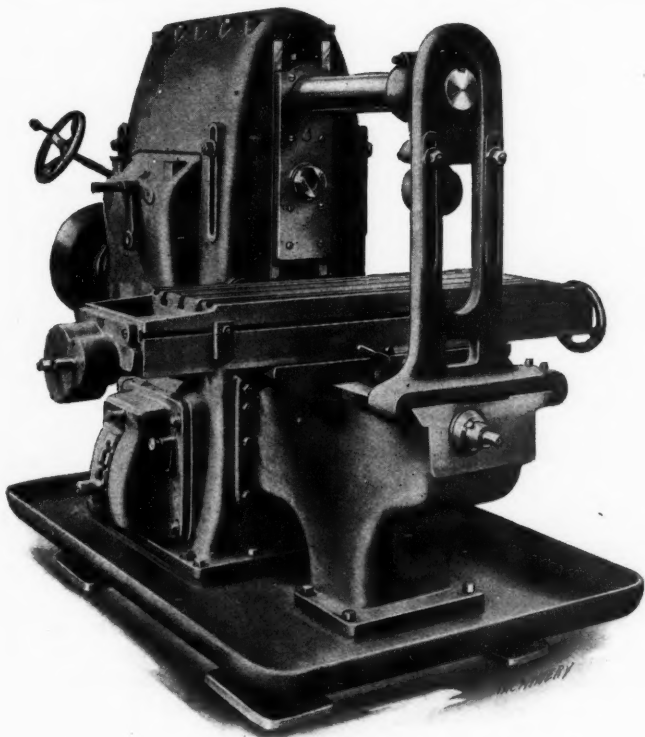


Fig. 1. No. 6 Manufacturing Milling Machine built by National Transit Pump & Machine Co.

side principle of the knee type of milling machine has been retained in the present design. It will be evident that the machine is intended primarily for manufacturing operations.

The column or main frame of the machine is a box section casting, and the spindle head is supported in this column on four separate guides. The front guides for the head are finished on their inner edge; these guides are of the narrow type, having a ratio of width to length of 1 to 5. All driving gears are of the spur type and they are liberally proportioned, as regards both pitch and face width, to insure smooth running and long life. The gears in the driving train and all other gears in the machine are made of machine steel, the blanks being press forged. The machine may be driven from an overhead countershaft, in which case a three-step cone pulley is mounted on the driving shaft; or it may be equipped with individual motor drive, for which purpose a five-horse-

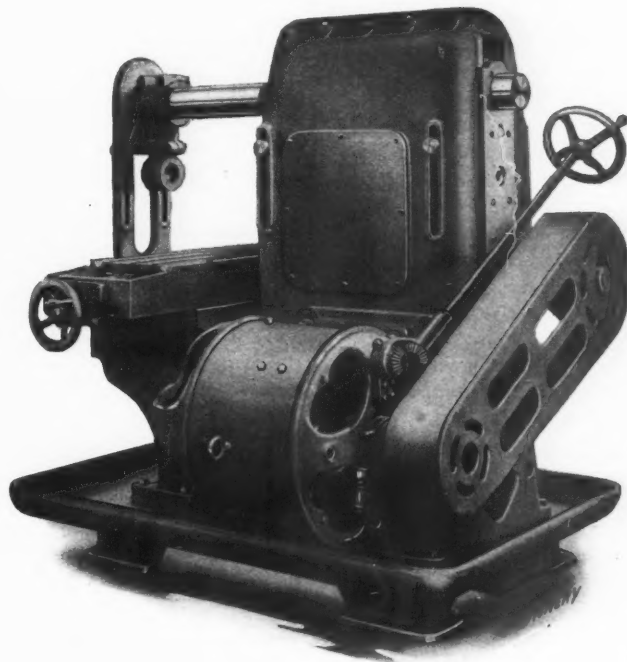


Fig. 2. National Milling Machine equipped with Motor Drive

power Reliance motor is recommended having a speed range of from 300 to 1200 revolutions per minute.

For a two-speed countershaft with speeds of 125 and 500 revolutions per minute, the available spindle speeds are 16, 20, 25, 33, 42, 54, 67, 85, 117, 139, 176, 224 revolutions per minute. There are two back-gear ratios of 5.9 to 1 and 2.8 to 1, respectively. Fig. 3 shows a cross-sectional view through the back-gear box. Changes are obtained by the upper lever in Fig. 1 which controls the pair of sliding gears to provide for obtaining either of the two available back-gear ratios. The two changes obtained in this way are multiplied by three by means of the cone pulley changes; and the six speeds available in the machine are again multiplied by two through the use of a two-speed countershaft.

A cross-sectional view through the spindle head and driving gear connection is shown in Fig. 4. The spindle is $3\frac{1}{4}$ inches in diameter at the front bearing and is bored for No. 11 B. & S. taper. The bearing is oiled by a wick which dips into a reservoir that is furnished with an overflow and a "wash-out plug" at the bottom. Fig. 6 shows a cross-sectional view of the table and saddle. The lower spline shaft runs direct from an inner-feed bearing. The feed-gear box is driven by

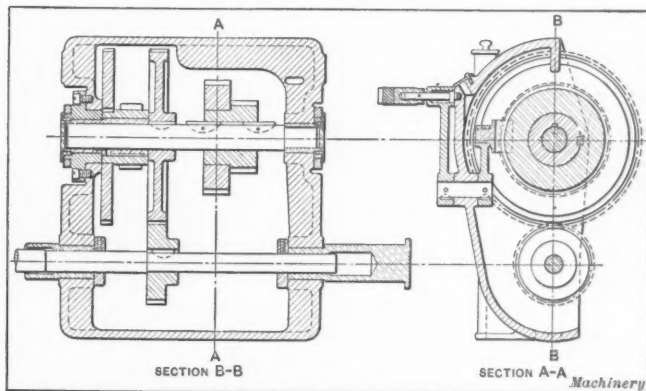


Fig. 3. Cross-sectional View of Back-gear Box, showing Arrangement of Sliding Gears

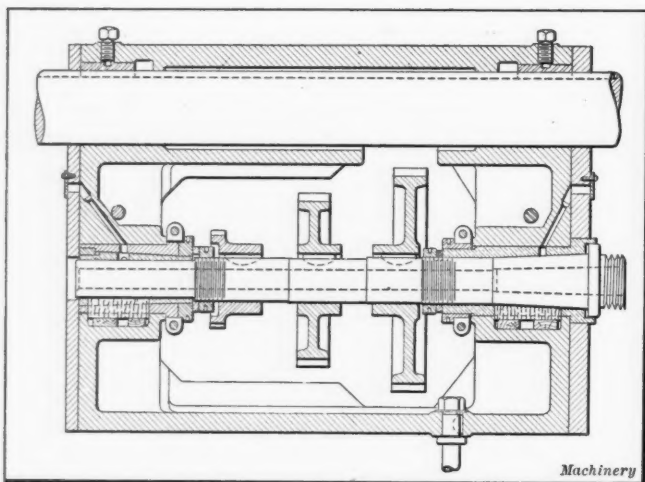


Fig. 4. Cross-sectional View of Spindle Head and Driving Gear Connections

a chain and means of adjustment are provided to take up any slack which may develop in the chain after it has been in service for a long time; the feed gear that drives the spline shaft rocks about the spline shaft gear, allowing $\frac{1}{2}$ inch vertical adjustment.

Reference to the cross-sectional view of the table will make it evident that all gears, with the exception of the reversing gears, are so proportioned that a speed reduction is obtained. The narrow guide principle is applied to the table on the working side; and the table is held down by a square clamp at the opposite side.

The feed trip is of the lever type and is located at the center of the front side of the table. Starting, stopping or reversing of the table is accomplished by one lever, with a push-pin that must be pushed in before the direction of feed can be reversed. It will be seen from Fig. 1 that the feed-box is cast in a single piece.

The gear system in this box is of the tumbler type, and eight changes of feed are provided by operating two levers. The range of feed is as follows: 0.007, 0.010, 0.013, 0.023, 0.068, 0.087, 0.122 and 0.202 inch per revolution of the spindle. Machines are also built with table feeds of 20, 30, 36 and 42 inches per minute.

The principal dimensions of these machines are as follows: range of vertical spindle travel, from $1\frac{1}{2}$ inch to $11\frac{1}{2}$ inches above the table; width of table, 13 inches; width of T-slots in table, $\frac{5}{8}$ inch; maximum adjustment of table in line with spindle, 12 inches; diameter of over-arm, 4 inches; diameter of spindle, $3\frac{1}{4}$ inches; diameter of hole through spindle, $1\frac{1}{16}$ inch; height of column from floor, 69 inches; floor space occupied, 68 by 68 inches; and weight of machine, 4200 pounds.

BROWN VERTICAL SURFACE GRINDER

The vertical surface grinding machine which forms the subject of this description is built by the Reed-Prentice Co., Worcester, Mass., this firm having acquired the interests of the Brown Cotton Gin Co., New London, Conn., by which the machine was developed. It will be seen that the grinding head is mounted on a cylindrical column

which is 12 inches in diameter. The head is elevated through the action of a spiral rack and worm; the worm is made of bronze and the rack of steel. Raising or lowering of the wheel head is controlled by the same lever that governs the table feed; but when this lever is used to change the elevation of the head, the clutch is first released to disengage the feed mechanism. The drive is carried from the vertical shaft at the back of the machine to the wheel-spindle by means of a 3-inch Link belt which is entirely enclosed and runs in oil.

Power to drive the feed mechanism is also taken from the main shaft by a pair of bevel gears. The length of table travel is conveniently regulated by making the required setting of adjustable dogs carried in a T-slot at the front of the table. There are three $\frac{3}{4}$ -inch T-slots in the top of the table to provide for securing work in place; and any standard form of magnetic chuck may also be used for this purpose. Six changes of feed are available, the range covered being from 2 to 12 feet per minute, which corresponds to feeds of 0.021, 0.043, 0.049, 0.063, 0.097 and 0.142 inch per revolution of the spindle. Means are provided for securing minute advances of the wheel to the work, the handwheel which governs this movement being graduated so that it is possible to obtain the required setting within 0.001 inch. The maximum hand adjustment of the grinding wheel is 5 inches; in addition, power feed is provided for raising or lowering the head through a greater distance than is possible by using the handwheel.

The spindle is usually driven at a speed of 1050 revolutions per minute when carrying a grinding wheel of the standard size which is 14 inches in diameter. The lower end of the spindle runs in an adjustable bearing 3 inches in diameter

by 8 inches in length; and the upper end of the spindle is carried by a sliding bearing with in the steel sprocket sleeve that drives the spindle. This upper bearing is $2\frac{1}{4}$ inches diameter by 8 inches long. The weight and thrust of the spindle is supported on ball bearings. The pull of the chain belt which drives the spindle is supported by the

sprocket sleeve, the end of which is held in a babbitted bearing in the head; and in this way all belt strain is adequately taken care of without any tendency to put an unnecessary load on the spindle itself.

The spindle is hollow and the supply of water is fed through it and delivered direct to the part of the work on which the grinding wheel is engaged; a centrifugal pump delivers a copious flow of water in this manner. At the back of the machine there is a large tank which is divided into two parts, one section of which serves to remove grindings and abrasive dust from the water before it is again delivered to the work; the other section of the tank contains the filtered water and

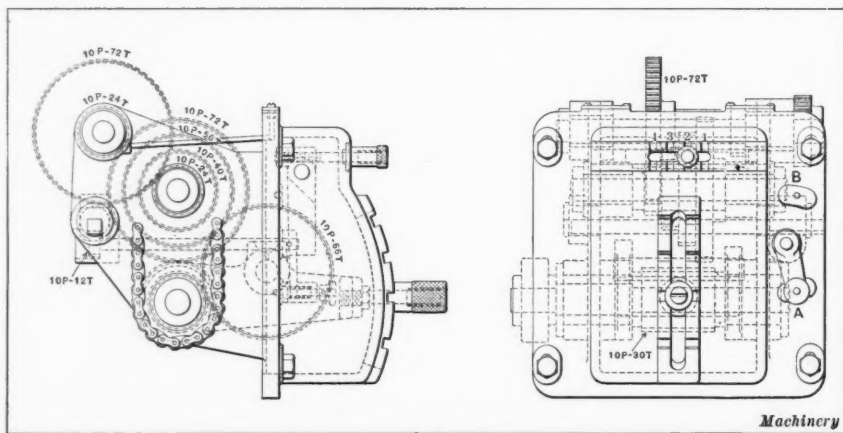


Fig. 5. Arrangement of Gearing in Feed-box of National Milling Machine

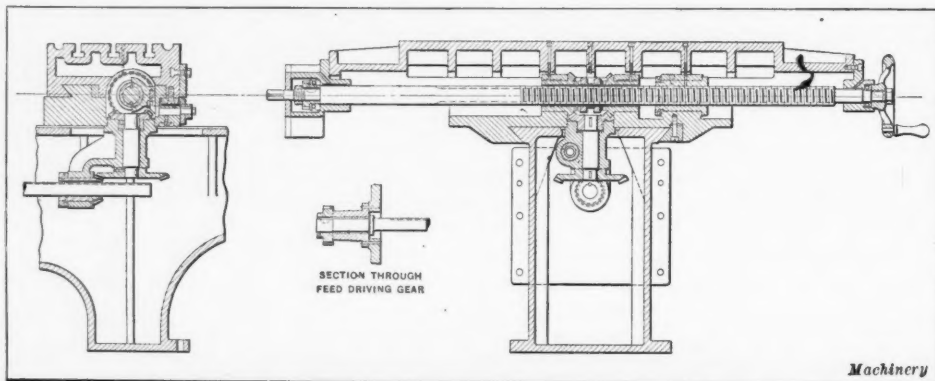
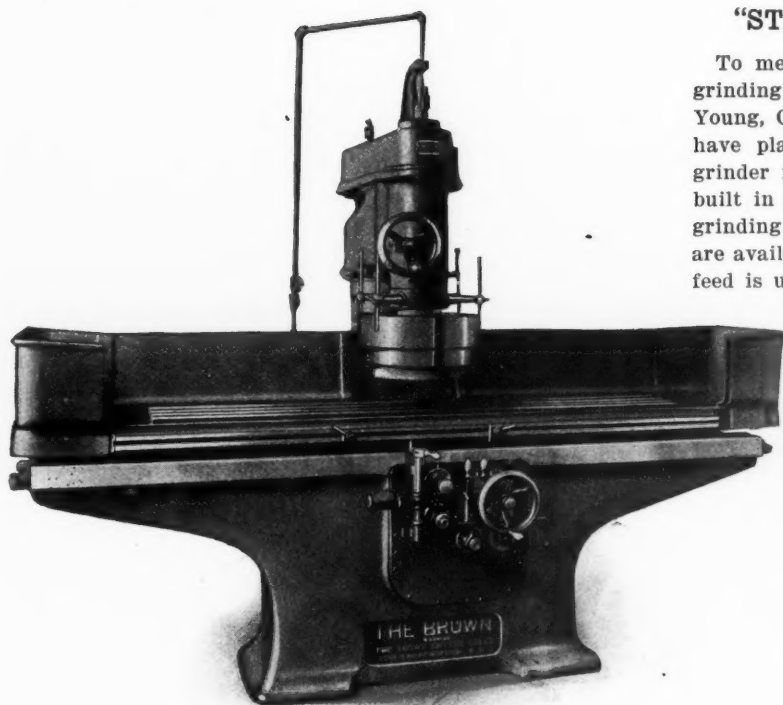


Fig. 6. Cross-sectional View of the Milling Machine Table and Saddle



Brown Vertical Surface Grinder built by Reed-Prentice Co.

is connected with the pump. The pump is driven by bevel gears which are secured to their shafts by friction disks of leather, these disks being tight enough to drive under normal conditions, although they will slip in the event of the pump becoming clogged, thus avoiding danger of damaging the mechanism.

The countershaft used in connection with this machine is equipped with a driving pulley 24 inches in diameter by 6 inches face width; and the tight and loose pulleys are 10 inches in diameter with a face width of 6 inches. The countershaft should be driven at 500 revolutions per minute. On the machine, there is a driving pulley 15 inches in diameter, which carries a 6-inch belt; this pulley runs at 750 revolutions per minute, and is mounted on the outside of a bronze sleeve, one end of which is clutched to the main driving shaft. Fifteen horsepower is required to drive the machine. The principal dimensions are as follows: size of table, 12 by 78 inches; maximum size of work which can be handled, 12 by 78 by 15 inches; with the table in its central position, the floor space occupied by the machine is 9 feet, 8 inches by 5 feet; with the table at one extreme of its travel, the floor space occupied is 16 feet, 2 inches by 5 feet. The net weight of the machine is 8000 pounds.

MILLER & CROWNSHIELD HAND-MILLING MACHINE

Miller & Crownshield, Greenfield, Mass., have added to their line a No. 3 hand milling machine which is of similar design to the hand milling machine formerly manufactured by this company, with the exception that it is provided with an over-arm and out-board support for the arbor. The principal dimensions of the No. 3 hand milling machine are as follows: maximum feed of table, 9 inches; cross-feed of saddle, $3\frac{1}{4}$ inches; vertical movement of knee, $6\frac{1}{2}$ inches; full size of table, $6\frac{1}{2}$ by 17 inches; maximum distance from table to center of spindle, $6\frac{3}{4}$ inches; width of driving belt, 2 inches; maximum vise opening, 2 inches; and weight of machine, 365 pounds.

"STERLING" CYLINDRICAL GRINDER

To meet the requirements of manufacturing plants where grinding operations have to be performed on cylindrical work, Young, Corley & Dolan, Inc., 149 Broadway, New York City, have placed on the market the 18 by 50 inch "Sterling" grinder illustrated and described herewith. The machine is built in plain and universal types, and may be equipped for grinding crankshafts and cam-shafts; hand and power feed are available on the machine. For manufacturing work, hand feed is usually preferred, and by using a wheel wide enough for the work the grinding operation may be completed without longitudinal travel. The standard wheel housing on the machine provides for taking a grinding wheel 20 inches in diameter by 2 inches face width; and special housings can be supplied to accommodate wheels of greater width. Power table feed may be supplied as an extra feature, and can be provided on plain machines. The construction is such that adjustable stops are mounted on a rail on the table and are set to engage a lever which reverses the feed. The feed is driven by cone pulleys from the main driving shaft and provides three changes; power cross-feed is not provided.

The main frame of the machine is made of semi-steel and ribbed to give the necessary rigidity. The table is supported by one flat and one V bearing, which are lubricated by automatic oiling rollers. The table can be set over to grind tapered work having a taper up to $1\frac{1}{2}$ inch per foot. The grinding wheel carriage is supported by one flat and one V way of the same form as those which carry the table, and it is actuated by a $2\frac{1}{2}$ -inch square-thread screw which dips into an oil bath so that adequate lubrication is insured. The wheel-spindle is made of high-carbon steel and runs in bronze-bushed bearings which are provided with means of adjustment for wear. Any length of work can be handled up to 50 inches. For crankshaft grinding only one steadyrest is employed, which is designed to take work up to 3 inches in diameter. The grinder can be equipped with a cam-shaft grinding attachment and provided with a mounting for any master cam which may be required for the work. The machine is driven from a floor type countershaft which does away with the necessity of using overhead works. This is convenient in places where the amount of overhead room is restricted. Where electric drive is employed, a slow-speed motor can be connected direct to the main driving shaft.

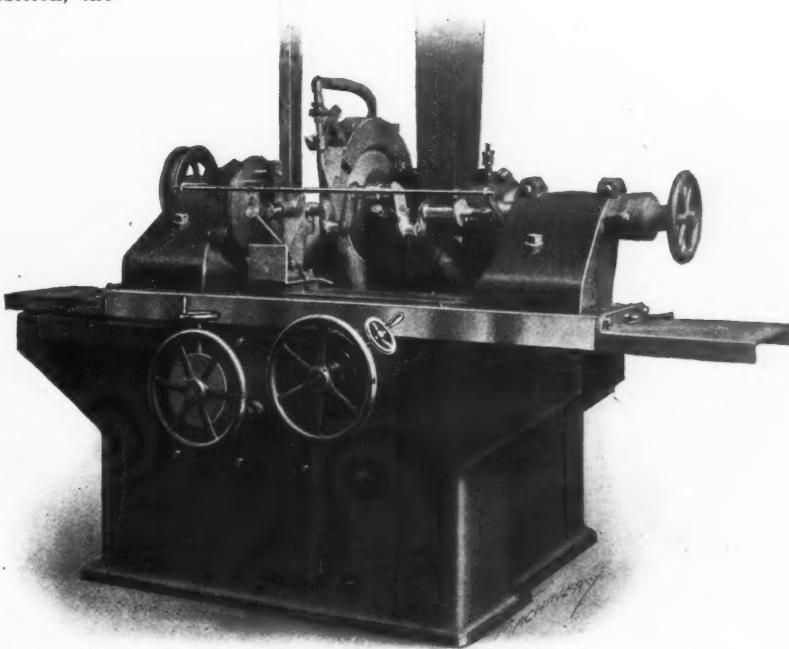


Fig. 1. Front View of "Sterling" Grinder built by Young, Corley & Dolan, Inc.

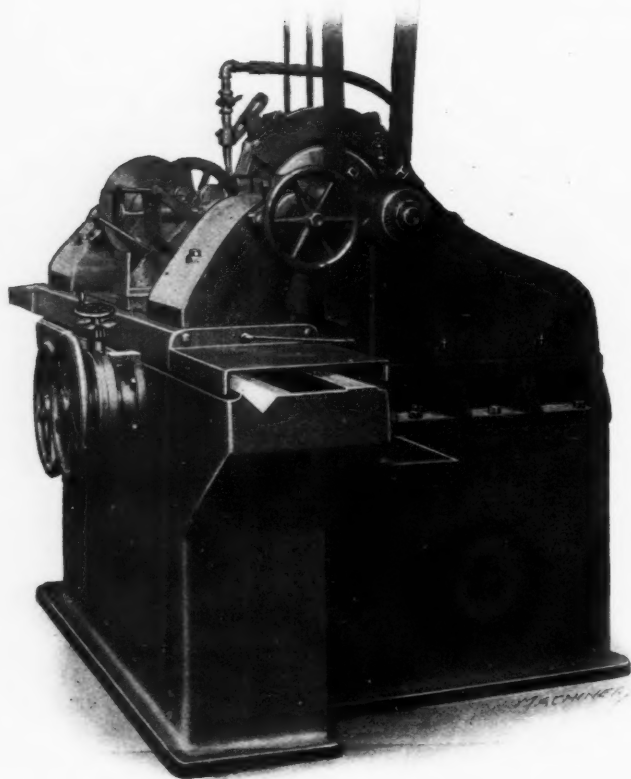


Fig. 2. End View of "Sterling" Grinder built by Young, Corley & Dolan, Inc.

The principal dimensions of this grinding machine are as follows: diameter of wheel used, 20 inches; width of wheel used, from 1½ to 2 inches; speed at which 20-inch wheel is driven, 1000 revolutions per minute; distance from floor to center of driving shaft, 10 inches; distance from floor to center of spindle, 42 inches; power required to drive machine, 10 horsepower; floor space occupied, 6 by 10 feet; and net weight, approximately 8000 pounds. The regular equipment furnished includes four work-rests; a pump, water tank, and water guard; a countershaft, driving drum, and bearing hangers; and the necessary wrenches for making all adjustments.

"ESCO" GROOVING MACHINE

This is a special machine designed for milling the powder grooves in shrapnel fuse time-rings to a uniform depth, width and length; the design is such that the groove is cut on a true circle. Adjustment is provided for milling grooves of any diameter up to four inches. The machine works within a limit of accuracy of 0.002 inch; and is capable of milling the groove in a fuse time-ring in thirty seconds.

One of the greatest troubles experienced by the manufacturers of war munitions since the opening of the European war has been the difficulty of obtaining in shrapnel fuse time-rings powder grooves of uniform depth, of absolutely true circumference, and with the length accurate to 0.001 inch. The nature of this work and the fact that standard machines have

proved unsatisfactory have led to the design of several types of fuse-ring grooving machines, ranging in form from lightly constructed drilling machines, modified and equipped with special attachments, to machines especially designed for this class of work, many of which, although they are an improvement in some ways, have been designed in a manner more or less cumbersome as well as intricate. In many cases two machines are used, one for roughing out and another for finishing the groove.

Because of the absolute accuracy required in the powder groove length, depth and width, which must be within limits of ± 0.002 inch, the Walco Mfg. Corporation, Providence, R. I., has designed a very simple but satisfactory machine for milling the powder groove or routing the vent chamber of fuse rings in one operation. This machine will groove the rings as rapidly as one in thirty seconds, and as it removes the chips as rapidly as they are formed, no trouble is experienced by the chips remaining in the groove. By a positive automatic feed and stop arrangement, no over-cutting or under-cutting on the length of the groove can occur. The depth of the groove is milled absolutely uniform, and the circumference is held absolutely true. The machine consists of two parts, the head or chuck frame being adjustable transversely for milling grooves of any size up to 4 inches in diameter. The chuck frame rests on a ½-inch scraped V-guide and a 2-inch scraped pad, which keep the head square with the bed of the machine. Adjustment transversely is accurately obtained by sliding the head on these supports; and two ⅝-inch set-screws, tightened against a lug which projects from the head into an opening in the machine frame, rigidly hold it in place. After the required adjustment is obtained, the head is firmly bolted down on the bed by two ¾-inch bolts. There is no possible chance for any variation in the diameter of the fuse-ring groove after the head is once adjusted and bolted down.

A ⅝-inch cutter-spindle revolves on ball bearings in a 3-inch cast-iron sliding sleeve in the frame casting, and is provided with a bronze taper bearing at the cutter end, which maintains the cutter absolutely true and smooth-running. Adjustment is obtained by lock-nuts at the end of the spindle. The cutter is fed into the work by the action of a crank lever which works in a bronze shoe on the side of the spindle sleeve. Accurate groove-depth adjustment is obtained by two lock-nuts at the rear end of the spindle sleeve. With these simple adjustments once made, the machine can be operated readily by unskilled labor. The cutter-spindle runs at 5000 revolutions per minute and is driven by a 3-inch tight pulley; the tight and loose pulleys run on a bronze bushing fastened in the spindle sleeve, so that the spindle is relieved of all belt strain. The action of feeding the cutter into and away from the work automatically shifts the belt on the pulleys, so that while the cutter is not in the work the spindle does not revolve; this prolongs the life of the bearings and also permits the changing of cutters when required.

The fuse ring is rigidly held in a rapid-operating chuck which consists of a steel cup eccentrically grooved at the sides and fitted over a cast-iron faceplate, on which the work

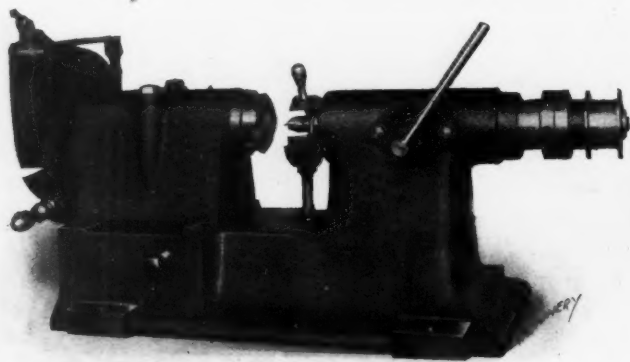


Fig. 1. "Esco" Fuse Time-ring Grooving Machine, showing Arrangement of Work-holding Fixture and Milling Cutter

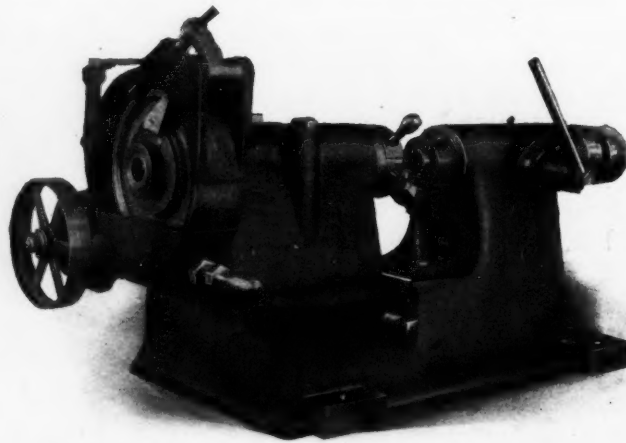


Fig. 2. Partial End View of Machine illustrated in Fig. 1, showing Arrangement of Work-spindle Drive

is clamped by turning the cup on pins projecting from the faceplate. A slight tap on the chuck handle instantly releases the cup and the fuse ring is taken out. The chuck is fastened into a 3-inch spindle 12 inches long, and is revolved according to the speed of operation desired, at from one revolution in thirty seconds up to one revolution in seventy seconds. The drive is provided by a worm meshing with a worm-wheel, and the power is transmitted through a pair of miter gears from a 7-inch pulley. Accuracy of groove length is obtained by an automatic knock-off stop arrangement, consisting of a hardened steel plate at the end of a long release arm, which rests on another hardened steel plate fastened to the worm casing. A 1/32-inch travel at the end of this release arm throws the worm out of mesh with the worm-wheel, instantly giving a positive stop. The starting point of the groove is maintained by an adjustable stop, previously set for the length of groove desired.

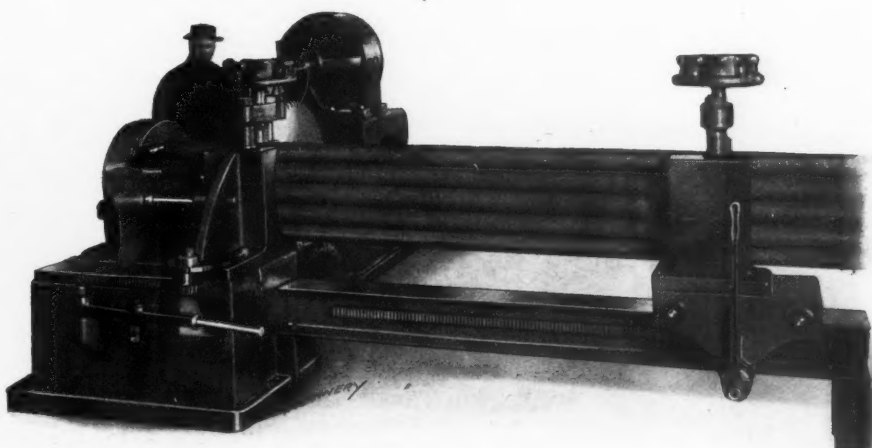
In operation, the ring is placed in the chuck, positioned by a center pin, the chuck clamped tight and brought up against the stop by one movement, the cutter fed into the work, and the automatic feed engaged. After the groove is milled, the machine stops automatically. The machine is rigid and substantial in every respect, requiring very few and simple adjustments. Several machines can be operated by one man, with an average production of fifty rings an hour per machine. The finished groove is cut from the solid ring in one operation, no finishing cut being required.

ESPEN-LUCAS SHELL BAR CUTTING-OFF MACHINE

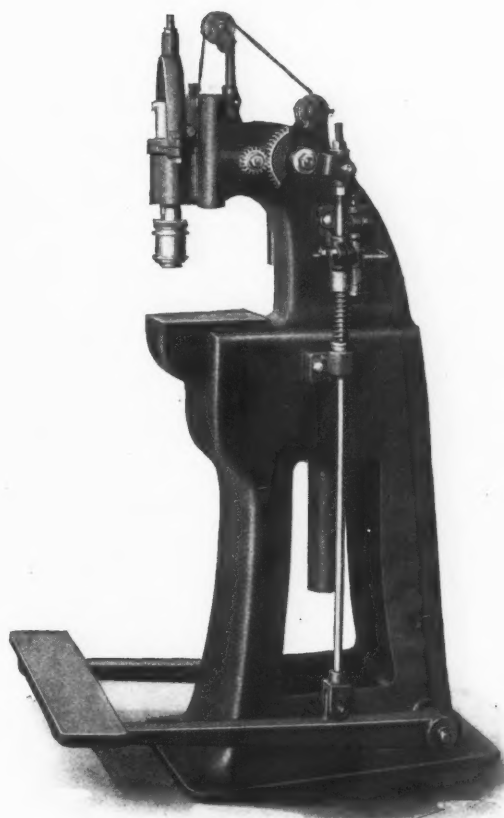
The accompanying illustration shows a cold saw built by the Espen-Lucas Machine Co., Philadelphia, Pa., which is particularly adapted for use in shell manufacturing plants. This machine is provided with a special clamping mechanism for holding five bars 3½ inches in diameter at a time. This special apparatus may be taken off the cutting-off machine, by the removal of a few bolts, and the machine is then ready for use as a standard cold-sawing machine. The object in designing this stock-holding device was to provide a radial arrangement of the bars to be cut off, so that the saw would sever them all in the same time that it would take to pass through one bar.

The stock brackets are curved so that the bars are held on an arc of the same curvature as the periphery of the saw. One stock bracket is held in a fixed position, and the other is mounted on a beam and is adjustable for the varying lengths of bars, by means of a hand-operated ratchet lever. The bars are clamped in the brackets by radius clamps, each clamp being pivoted upon one of the two clamping bolts to enable them to swing out of the way for inserting or removing bars. For this purpose, it is only necessary to loosen the clamps and swing them away from the second clamping bolt. The hand-wheel of each clamp is so designed that after bringing it down on the work, a bar may be inserted and the stock then tightened firmly in position.

As will be seen from the illustration, the usual pin method of gaging the lengths to be cut off has been discarded and a cam plate used. This plate may be seen in the illustration; it is swung into position when the stock is moved out ready for a new cut, and swung out



Espen-Lucas Cold Saw with Special Rack for cutting off Five Shell Blanks at a Time



No. 2 Pneumatic Riveter built by Blomquist-Eck Machine & Mfg. Co.

of the way while the machine is in action. This special clamping mechanism can be furnished for holding three 6-inch bars instead of five 3½-inch bars, if so desired. The saw is fed at the rate of ⅞ inch per minute, and guaranteed production from the machine is forty cuts of 3½-inch bars per hour. The approximate weight of the machine and clamping mechanism is 17,000 pounds.

BLOMQUIST-ECK PNEUMATIC RIVETER

The No. 2 pneumatic riveting machine illustrated and described herewith is a recent addition to the line of machinery built by the Blomquist-Eck Machine & Mfg. Co., 203 St. Clair Ave., N. E., Cleveland, Ohio. There are many classes of work that are assembled by the operation of forming a head on one of the parts, and on which this head cannot be formed by compression under steady pressure, owing to the distortion which would result in other portions of the work. It is for performing operations of this kind that the Blomquist-Eck No. 2 pneumatic riveting machine is particularly adapted.

The anvil base is heavily built to absorb vibration, and the design of the one-piece bed and frame gives extreme rigid-

ity and strength. The hammer, which is of standard design, is mounted on a balanced slide provided with a tapered gib adjustment, and there is a vertical movement of 4½ inches for the slide. The hammer set is revolved by a belt from the pulley at the side of the machine, from which power is

transmitted through bevel gears to the vertical drum. A flat belt from this vertical drum drives a pulley on the hammer, thus causing the hammer set to revolve. The face of the set is cut away in order to make the blow more effective.

The movement of the hammer slide, as well as the admission of air to the cylinder, is controlled by a foot-treadle, so that both of the operator's hands are left free to handle the work. The cam on the right-hand side of the machine is adjustable so that admission of air can be controlled in this way. This pneumatic riveting machine is especially adapted for the performance of riveting operations on automobile wheel rims, and the anvil base can be designed to serve the purpose of a "horn" if so desired. The depth of throat is $9\frac{3}{4}$ inches, and the maximum distance from the anvil base to the face of the hammer is 7 inches.

"SIMPLEX" HEAVY-DUTY LATHE

The heavy-duty single-purpose lathe which forms the subject of this description is manufactured by the Cleveland Machinery & Supply Co., Cleveland, Ohio, and is made in three sizes, viz., $26\frac{1}{2}$ -inch swing with a 12-foot bed; 20-inch swing with a 10-foot bed; and 16-inch swing with an 8-foot bed. Any of these sizes may be furnished with a bed of additional length, if so desired. It will be evident from the illustration that the outstanding features of these machines are strength of construction combined with ample power for the performance of heavy manufacturing operations. The lathe is well adapted for shell manufacture, and special attachments may be furnished for handling work of this kind. The illustration shows a $26\frac{1}{2}$ -inch machine with the tailstock removed and a special carriage substituted to adapt the machine for the performance of heavy shell boring operations. Kellogg & Co., 120 Broadway, New York City, are selling agents for this machine.

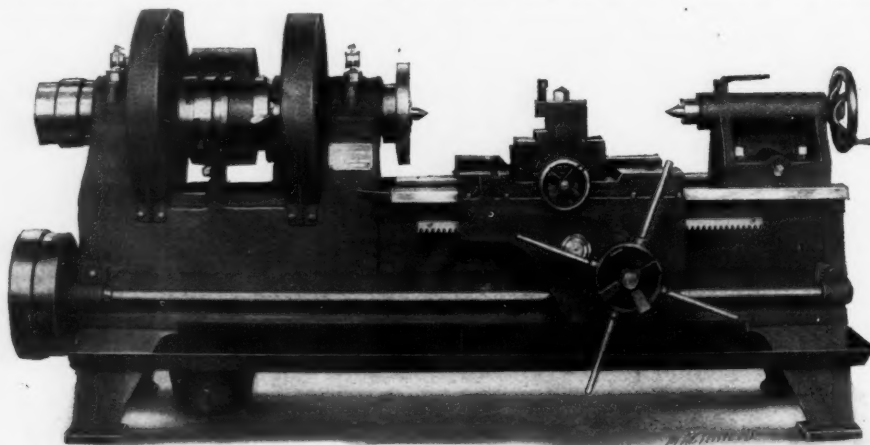


Fig. 1. Johnston & Jennings 20-inch Manufacturing Lathe built with 8- or 10-foot Bed

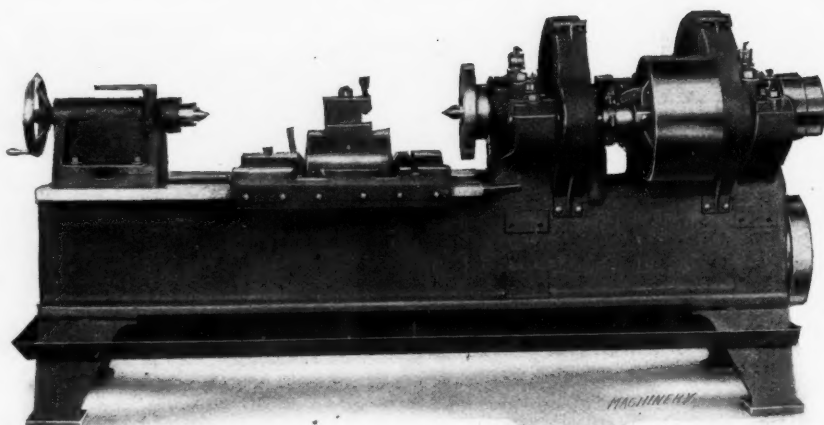


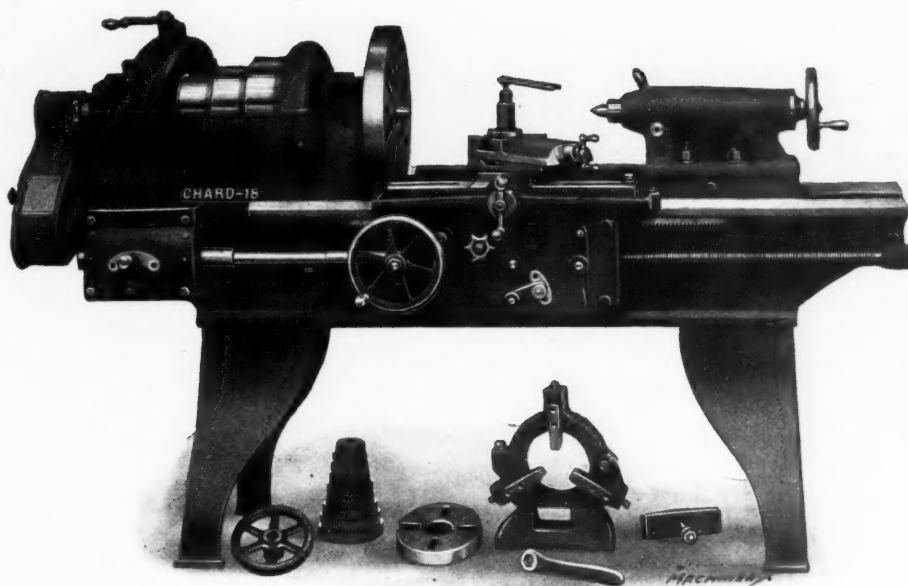
Fig. 2. Opposite Side of Johnston & Jennings Lathe, showing Arrangement of Single Pulley Drive

JOHNSTON & JENNINGS LATHE

The accompanying illustrations show front and rear views of a 20-inch manufacturing lathe recently placed on the market by the Johnston & Jennings Co., Cleveland, Ohio. When so desired, this machine may be furnished with a six-hole turret; and the oil pump on these turret lathes delivers the oil through the base of the turret to the individual turret tools.

As the machine is intended for manufacturing work, a sufficient range of speeds is provided by a single pulley drive and double back-gears, having ratios of 5 to 1 and 6 to 1. The driving pulley is mounted on the back-gear shaft and provided with an expanding clutch which is operated by the upper of two hand-levers which will be seen at the front of the headstock in Fig. 1. This lever provides for starting or stopping the drive, as required. Between the two sets of gears on the spindle, there are positive tooth clutches which are controlled by the lower of the two hand-levers on the head. This lever can be set in the neutral position in order to disengage both sets of gears; and by throwing it to the right or left, either of the two sets of gears may be engaged according to the speed which is required. When one set of gears is engaged, the other is idle, and *vice versa*. It will be seen that the feed-rod is driven by a two-step cone pulley, mounted on the end of the spindle, and in this way two changes of feed are provided.

Other features of the machine are so simple that they will be readily understood by reference to the illustration; but attention may be called to the fact that the design has been worked out along extremely simple lines, and that all parts of the machine are made very heavy, so that ample strength is provided to handle the heaviest classes of manufacturing operations. The principal dimensions of the machine are as follows: distance between centers for a lathe with an 8-foot bed, 36 inches; number of feed changes, 2; available rates of feed, $1/16$ inch and $1/20$ inch per revolution of the spindle; swing over bed, 20 inches; swing over tool-slide, 10 inches. This machine is built with 8- and 10-foot beds, according to the requirements of the work.



Engine Lathe built in 18-, 20-, 24- and 28-inch Sizes by Chard Lathe Co.

CHARD ENGINE LATHES

The Chard Lathe Co., Newcastle, Ind., is now building engine lathes in 18-, 20-, 24- and 28-inch sizes. These machines can be provided with a four-step cone pulley and single back-gears or with a three-step cone pulley and double back-gears; and they are built with quick-change and semi-quick-change gear-boxes. A taper attachment will be furnished when required, as well as a compound turret tool-block and front and rear tool-blocks. All parts and attachments for the Chard lathe are interchangeable, so that new parts may be provided at any time with the assurance that they will fit without the necessity of hand work.

The spindle bearings are lined with an alloy composed of 86 per cent tin, 7 per cent antimony, and 7 per cent copper. The spindle is made of steel of the following analysis: 0.45 to 0.55 per cent carbon; 0.50 to 0.60 per cent manganese; 0.03 per cent phosphorus; 0.035 per cent sulphur, and 0.20 per cent silicon. The spindles are machined from forgings which are hammered down from 6-inch billets; after the forging operation, the steel is thoroughly annealed, then reheated to a temperature of from 1525 to 1550 degrees F. and quenched in water; after this heat-treatment, the forgings are re-annealed at a temperature of from 1225 to 1250 degrees F. The rack is made of 0.40 to 0.50 per cent carbon steel. The tops of all Chard lathe beds are chilled so that the metal is 20 per cent harder at the top than the surface of any part sliding on the bed. The top of the lathe bed is chilled to a depth of over $\frac{5}{8}$ inch below the bottom of the V, which gives a degree of hardness that insures the maintenance of perfect alignment of the bed. All castings are pickled and sandblasted before being machined.

The cross-feed and compound rest are provided with large graduated collars reading to 0.001 inch; and the figures are large and distinct so that they may be easily read. The dovetail on the carriage is inverted in order to obtain greater strength through the bridge. The carriage is provided with shear wipers and an oiling device which is an integral part of the carriage. The movement of the carriage on the bed is perfectly free and requires only a slight exertion on the part of the operator. The cross-feed and compound rest move in a similar manner. This ease of movement is brought about by accurate alignment and accurate fitting of all parts of the lathe. The apron has a double bearing for all studs due to the double-plate type of construction. All bearings in the back-plate are oiled from one oil hole in the top of the carriage, and there are no gears running on fixed studs.

Particular attention is called to the fact that the handles on the hand-wheel on the apron and cross-feed crank are made in such a way that the hand-grips do not revolve in the operator's hand. These grips revolve on fixed studs so that the operator is enabled to take a firm hold of either handle and turn it without the handle slipping around in his hand. The action is somewhat similar to that of the familiar bit brace used by carpenters, where it will be recalled that the wooden handle rotates on the brace without itself turning in the workman's hands.

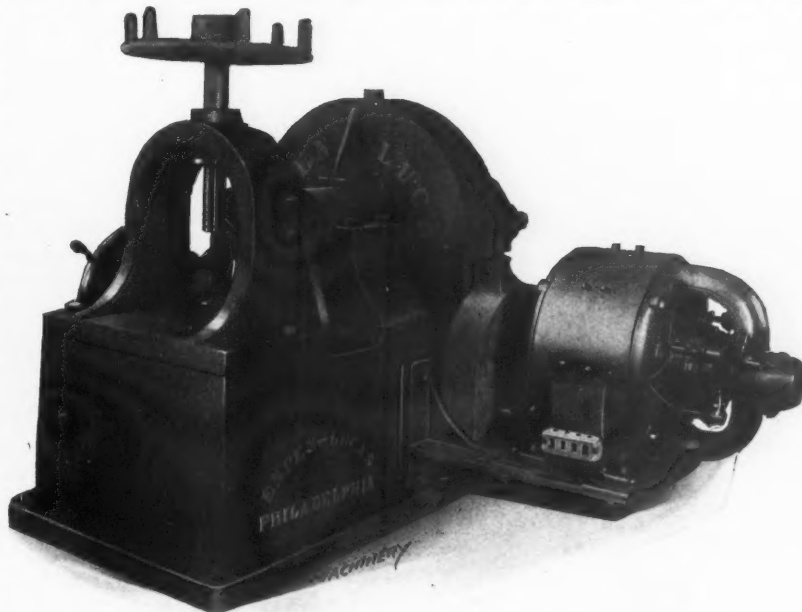
The legs have a three-point bearing which does away with all possibility of springing the bed when the legs are bolted in place. The tailstock is graduated to provide for setting it over for taper turning operations; and the faceplate on the headstock is made exceptionally heavy, a large and a small faceplate being furnished as part of the regular equipment. All Chard lathes are designed on "Safety First" principles, the gears and other dangerous mechanisms being completely enclosed to provide for the safety of the operator.

ESPEN-LUCAS RAIL-ENDING MACHINE

In the manufacture of rails, it is customary to size them to uniform length by milling off the excess stock from the end. For the performance of this operation, the Espen-Lucas Machine Co., Philadelphia, Pa., has brought out a rail-ending machine which is shown in the accompanying illustration. This machine was developed for the sole purpose of facing the ends of rails of any weight up to 150 pounds to the foot.

The machine is of comparatively simple construction. Upon the heavy base, the spindle is mounted in large bearings; and at one end of the spindle is mounted the cutter-head that carries an 18-inch three-blade face-mill of patented construction. At the rear or driving end, there is a large worm-wheel and worm that are driven by the fifteen-horsepower motor that may be seen at the side of the machine. It is evident that on a machine of this type, the thrust is very great, and on this Espen-Lucas rail-ending machine, it is taken on a roller thrust bearing of large diameter.

The spindle is provided with a 4-inch longitudinal travel; the feed is of a friction type, and there is a hand-feed wheel that may be seen at the left of the machine for bringing the



Rail-ending Machine built by Espen-Lucas Machine Co. for milling off Rails to Standard Length

cutter-head up to the starting point of the cut. The power feed is at the rate of 1 inch per minute. The approximate weight of the machine is 17,000 pounds.

HARRIS RIFLE SIGHT LEAF NOTCHING MACHINE

The rear sight leaf of the Russian military rifle has ten irregularly spaced notches cut in each of its reinforced edges. As the accuracy of the rifle is dependent upon the precision with which these notches are cut, it is apparent that the greatest care must be taken in the performance of this operation. The limit of accuracy is 0.001 inch over the entire length of the sight leaf. To attain this result and to enable the work to be done as rapidly as possible, the special machine described in the following article was developed. One operator can look after several machines, and the rate of production is unusually high.

The rear sight leaf of the Russian military rifle is supported on a hinge in order that the sight may be set in the proper position to get the required elevation for the muzzle of the rifle for any desired range. This rear sight leaf is of a rather peculiar form, being curved to a radius of about 16 inches and having twenty irregularly spaced notches cut in the reinforced edges at an angle of 45 degrees. There are ten of these notches on each side of the sight leaf and they are V-shaped. Owing to the fact that the accuracy of the finished rifle is dependent upon the precision with which these notches are cut in the rear sight leaf, it is necessary for the spacing to be as accurate as possible.

Various methods have been tried for doing this work, and the most successful attempt to use a standard machine was made with a punch press equipped with a tool for cutting ten notches on one side of the sight leaf at a time. Using a solid toothed tool and a special work-holding device on the bolster of the press, which was provided with a slide to be operated by hand, it was found possible to accomplish the desired result, although the method left a great deal to be desired. One of the obvious defects was that the mechanism was operated by hand, and hence there was danger of the operator moving the work at the wrong time. A more serious defect lay in the difficulty of making a solid tool and holding the required relation between the positions of the ten irregularly spaced cutting teeth during the time that the tool was being hardened. As the limit on the location of the notches in the rifle rear

sight leaf is 0.001 inch for the total length of the sight, it will be apparent that this was a particularly difficult problem to solve.

With the view of developing a more efficient method of handling this work, the H. E. Harris Engineering Co., 1041-1055 Broad St., Bridgeport, Conn., recently brought out the special machine illustrated and described herewith. Owing to the delicate nature of the work and the peculiarities of its design, and as the clearance in which the tools have to work is very small, the machine had to be carefully designed with the view of eliminating backlash in the reciprocating parts. Provision also had to be made for taking up any lost motion which is likely to develop as the result of wear.

At the top of the machine, opposed to each other and inclined at angles of 45 degrees to the vertical center line, there are two slides or rams somewhat similar in design to the ram of an ordinary shaper. Special tool-holders are mounted on these rams, which carry tools for cutting the notches in both sides of the rifle sight leaf at the same time. The tool-holders which carry the tools used for this purpose must be very carefully made, the same precision being required as in the manufacture of high-grade gages. All of the tool-holders must be made of exactly the same dimensions so that they are interchangeable with any other tool-holders that are used; and each machine is supplied with an extra set of tools and holders so that there will be no interruption of the work while tools are being ground other than that involved in making a change of tools.

The actual working time of the machine on each part is less than five seconds. The machine runs very slowly and develops no vibration. The average speed of the tool is about six feet per minute, but during the actual cutting operation it is much slower than this, as the cutting is done during the time that the crank is going over the dead center. When grinding the tools, they are merely set out a little further by means of adjusting screws in the tool-holder, after which the entire set of tools is ground at the same time, the surface grinder on which the work is done being equipped with a special fixture for this purpose. An idea of the efficiency with which this special rifle sight leaf notching machine operates will be gathered from the fact that the output is said to be equivalent to that of eight men operating standard punch presses and tools of the type referred to in a previous paragraph. In replacing broken or worn out tools in different tool-holders, it is merely necessary to replace the individual tools as they are worn out, and the original accuracy of the set-up is not in any way affected by the substitution of one or more new tools in the set.

The work is held between vise jaws on top of the vertical slide which will be seen at the center of the machine. This is operated automatically while the notches are being cut in the leaf by means of a crank motion, and a fine tooth ratchet to elevate the slide. As soon as the crank has passed the highest part of its cycle, the cut has been made to the required depth. The mechanism is then automatically released and the operator lowers the vertical slide to the bottom of its travel by means of a crank handle at the front of the machine, after which the work is released from the vise jaws by turning a small crank. A new blank is then set in the vise, secured in place and the machine is ready to perform the next cycle of operations.

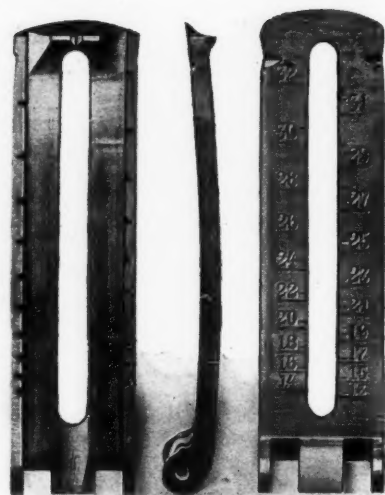


Fig. 2. Sight Leaf showing Notches cut by Machine in View at Left

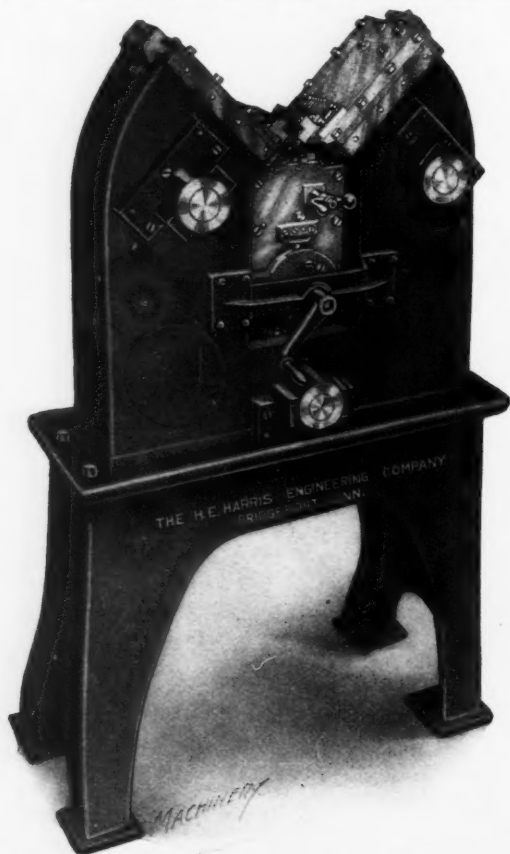


Fig. 1. H. E. Harris Machine for notching Rear Sight Leaf of Russian Military Rifle

As the relation between the positions of the hinge hole in the sight leaf and the notches cut at each side of this leaf must be uniform, it will be seen that great care must be taken to have the two tool-slides and the vertical slides which carry the work set in exactly the proper relation to each other. This calls for fine workmanship in making the machine and the provision of means for taking up any wear which may develop after the machine has been in use for some time. Individual means of adjustment are provided for regulating the depth of stroke on both the cutting slides and the height of the work-holding slide. These adjustments are very accurate, but the means provided on the machine enable them to be made very rapidly.

DAVENPORT HAND MILLING MACHINE

The Davenport Mfg. Co., Meadville, Pa., is now building a heavy-duty hand milling machine, which is illustrated and described herewith. The table of this machine has a longitudinal movement of 6 inches with one setting of the hand-lever, and a total range of feed of 16 inches. The transverse movement of the saddle is 6½ inches and the vertical movement of the knee, 19 inches. The table has a working surface of 24½ by 8 inches and is furnished with a ⅝-inch T-slot. Adjustable stops provide for limiting the movement of the table in either direction.

The spindle is made from a crucible steel forging and runs in bronze-bushed bearings which are provided with means of compensation for wear. The spindle is 2½ inches in diameter and the socket is bored No. 10 B. & S. taper. The nose of the spindle is 2¼ inches diameter, and it is threaded with ten right-hand threads per inch. A ⅝-inch draw-back screw provides for holding the arbor in place. The knee is heavily constructed and accurately scraped to fit the bed and saddle; and a telescopic screw is used to afford the required vertical movement without the necessity of cutting a hole through the floor to accommodate the lower end of the screw when the knee is in its lower position. The overhanging arm, which is made of steel, is 3¼ inches in diameter; and the under side of this arm is 6⅝ inches from the center of the spindle. An arbor 1 inch in diameter by 7½ inches in length under the nut is furnished as part of the equipment of the machine. The arbor support is bronze-bushed.

Micrometer adjustment is furnished for the vertical and horizontal feed-screws, by collars which are graduated to .0001 inch. The oil pot which has a capacity of two quarts is supported by an adjustable bracket and is fitted with a stop-cock. It will be seen that the machine is driven by a three-step cone pulley which carries a belt 2½ inches in width. A two-speed countershaft is used, which should provide speeds of 125 and 165 revolutions per minute. The clutch pulleys are self-oiling, these pulleys being 10 inches in diameter by 3 inches face width. The floor space occupied is 46 by 46 inches, which includes the limit of table travel; and the weight of machine is 1200 pounds.

Heavy-duty Hand Milling Machine built by Davenport Mfg. Co.

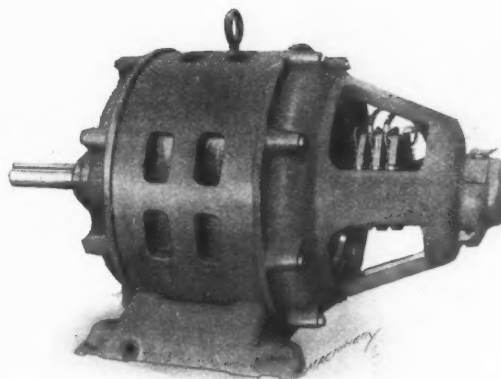


Fig. 1. Westinghouse 75-H.P. Type CI Slip Ring Induction Motor with Rolled Steel Frame Construction

WESTINGHOUSE INDUCTION MOTORS

To meet the requirements of severe intermittent service with varying conditions of speed, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has recently developed a line of Type CI slip ring induction motors. These motors are especially adapted for use on heavy-duty cranes or hoists, draw-bridges, roller lift bridges, railway turntables, transfer tables and similar installations. They are made in sizes ranging from 1½ to 200 horsepower, for operation on 25- or 60-cycle two- or three-phase circuits of 220 or 440 volts.

The frames of the smaller sizes are made up of steel laminations riveted between forged steel housings; and in the larger sizes the frames are made of rolled open-hearth steel. The brackets are of cast-iron with reinforcing ribs to insure rigidity and perfect alignment of the bearings at all times. The bearings are of the oil-ring type; and the steel brush-holders are supported by and insulated from the bracket which is opened to permit of inspection and renewal of the brushes.

The rotor is small in diameter, thus reducing the flywheel effect. This feature, together with perfect balance and secure attachment of the windings, makes these motors especially adapted for frequent starting, stopping, and reversing. The shaft is of axle steel and can be removed from the rotor without disturbing the windings. The running torque of these motors is the maximum obtainable, and the starting and pull-out torques in all motors exceed twice the full-load torque. They are so constructed that in case of accident repairs can be quickly made; and maximum strength is obtained, while weight and over-all dimensions have been reduced to a minimum.



Fig. 2. Westinghouse 10-H.P. Motor of Type shown in Fig. 1, but with Built-up Frame Construction

ACME THREADING DIE CHASER GRINDER

The threading die chaser grinder illustrated and described herewith is a recent addition to the line of the Acme Machinery Co., Cleveland, Ohio. It will be seen that the machine is of the single wheel type, and adjustment is provided which enables all sizes of dies to be ground with the same wheel, thus avoiding the necessity of changing grinding wheels for sharpening various sizes of chasers, and saving the cost of extra wheels. The grinding wheel used on the machine is 6 inches in diameter by ¼ inch face width. The correct angles for the die throat are obtained by moving the die-slide and die-holder to the proper positions, as indicated by graduated plates on the slide base and die-holder. The setting is quickly and easily made.

There is a point in the grinding of die chasers which is not very clearly understood. In regrinding a threading chaser,

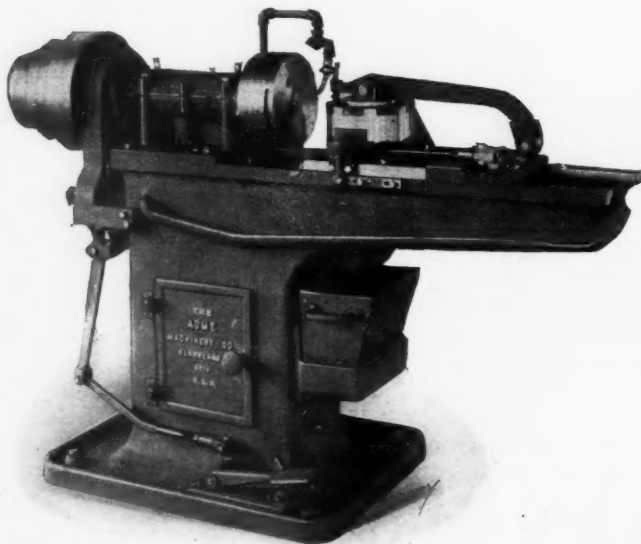


Acme Threading Die Chaser Grinder

it is essential that the entrance or throat be not unnecessarily enlarged, but the throat angle should be reduced. This is not always done, with the result that the greatest efficiency is not obtained from the chasers. Another point is to have all the chasers in any one particular head with the same throat angle and starting at the same point. This is made possible by the Acme die grinder, due to the design of the fixture in which the chasers are set for grinding. The wheel-spindle is made of crucible steel and runs in bronze-lined bearings. The die-slides are carefully scraped to fit, and gibs are provided to afford means of compensation for wear. The work is moved vertically to the grinding wheel by means of a hand-screw located beneath the slide, and horizontally to the grinding wheel by a hand-lever. The principal dimensions of the machine are as follows: size of driving pulley, 8 inches in diameter by 1 3/4 inch face width; size of tight and loose pulleys, 4 inches in diameter by 1 3/4 face width; speed of countershaft, 1000 R. P. M.; speed of grinding wheel spindle, 4000 R. P. M.; floor space occupied by machine, 23 by 20 inches; and net weight, 200 pounds. The equipment furnished includes a countershaft, two grinding wheels, and the necessary wrenches.

ACME TURRET TYPE BOLT POINTER

The feature of particular interest on the bolt pointer illustrated herewith, made by the Acme Machinery Co., Cleveland, Ohio, is the indexing turret which is provided so that the machine can be kept in practically continuous operation. The work is placed in holders, eight of which are carried in the

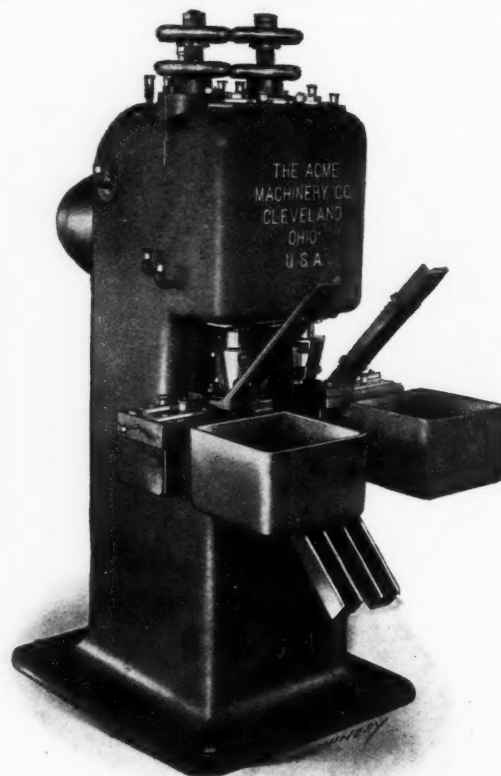


Turret Type Bolt Pointer built by Acme Machinery Co.

top face of the turret which is indexed automatically. When the work is indexed into the working position, it is clamped by a fulcrum lever over the top of the turret, that comes into action on the work as the turret slide advances. The machine is provided with a three-step cone pulley, so that suitable speeds can be obtained for different diameters and materials. The foot-lever shown on the right-hand side is for stopping and starting the turret, which is done through a clutch. When the machine has been properly set up, the foot-lever is depressed and held down by means of a catch until it is necessary to stop the machine in case of accident or for some other emergency. The operator is merely required to load the work into the turret as the bolts are automatically ejected.

ACME DUPLEX NUT BURRING MACHINE

The nut burring machine which forms the subject of this description and which is a recent product of the Acme Machinery Co., Cleveland, Ohio, was designed to remove the burrs



Two-spindle Nut Burring Machine built by Acme Machinery Co.

from both square and hexagon hot-pressed nuts. The work is placed in the feed chutes by hand, after which the operation is automatic as regards feeding the blanks to the spindles, performing the burring operations and ejecting the finished nuts. The mechanism is enclosed in the bed of the machine where it is thoroughly protected from dust and grit; but the design has been worked out in such a way that all parts of the mechanism are readily accessible. The shafts and gears are made of steel, and the bearings are bushed with bronze. Lubrication is afforded by pipes leading to each bearing.

The nut feeding mechanism is simple and positive in its action. The nuts slide down the feed chutes to the burring plate which carries them under the spindles. If for any reason a nut gets stuck, a spring release mechanism causes the feed to stop; but the feed will start again automatically as soon as the nut is free. Each cutter-head carries three cutters arranged so that they may be easily removed for dressing. These heads are adjusted to the work by means of hand-screws located at the top of the machine. The cutters are held against the work by the weight of the spindle and head, assisted by a spring which allows the cutter to rise and thus prevents damage in case a nut of unusual thickness is fed into the machine. The spindles are provided with ball thrust bearings, and are lifted by cams cut in the side of the driving worm-wheels.

The drive is through a three-step cone pulley from which power is transmitted through bevel gears to the worms and worm-wheels which drive the spindles. Working on $\frac{5}{8}$ -inch nuts, the capacity of this machine is 4500 per hour.

This duplex nut burring machine is made in three sizes with nominal capacities of $\frac{5}{8}$ inch, 1 inch and $1\frac{1}{2}$ inch, respectively. The $\frac{5}{8}$ -inch machine is suitable for working on 5/16-, 3/8-, 7/16-, 1/2-, 9/16-, and 5/8-inch nuts; the 1-inch machine for $\frac{1}{2}$ -, $\frac{5}{8}$ -, $\frac{3}{4}$ -, $\frac{7}{8}$ - and 1-inch nuts; and the $1\frac{1}{2}$ -inch machine for 1-, $1\frac{1}{8}$ -, $1\frac{1}{4}$ -, $1\frac{3}{8}$ - and $1\frac{1}{2}$ -inch nuts. The equipment furnished with these machines includes a countershaft, wrenches, automatic feed mechanism, and one set of cutter blades. Five sets of adjusting strips are included in the equipment for handling these sizes of nuts, and also five nut pilots for handling the sizes of work referred to.

BOWEN MILLING MACHINE

It will be seen that this machine may be used for either vertical or horizontal milling, but it was especially designed

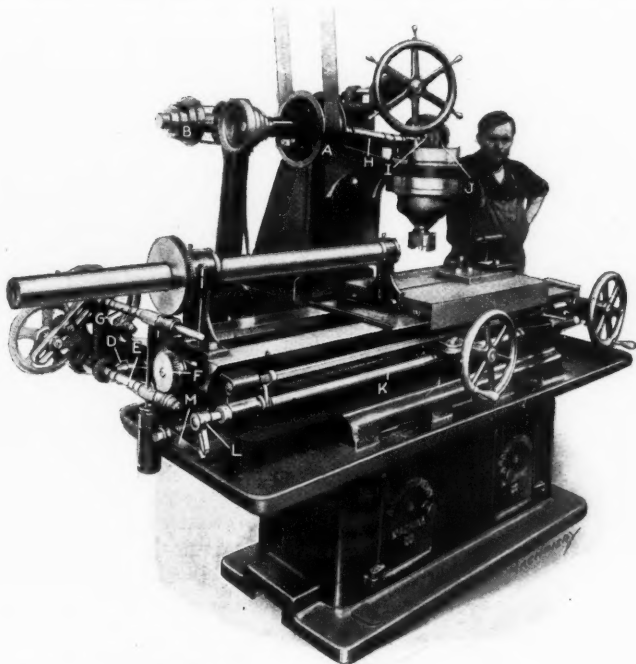


Fig. 1. Bowen Milling Machine built by Bond Foundry & Machine Co.

for the performance of various thread milling operations. A feature of the design is that the machine does not require a special lead-screw for each pitch of thread to be cut. The vertical position of the table is fixed, and adjustment for depth of cut is secured by moving the cutter-head on its bearings on the column. Lateral adjustment is obtained by moving the cutter-head column in or out from the table; and the table is traversed by a lead-screw.

The Bond Foundry & Machine Co., Manheim, Pa., has perfected and placed on the market the Bowen milling machine illustrated herewith. This machine was designed by James E. Bowen, mechanical engineer of this firm, who was formerly with the Milled Screw Co., Sayre, Pa. While this is a universal milling machine, in that it can be used for vertical or horizontal milling of almost any type, it is particularly adapted for thread milling; and Fig. 3 shows the machine set up for milling a helical groove. Unlike many thread milling machines, it does not require a special lead-screw for every pitch of thread to be cut.

The table of the Bowen milling machine is non-adjustable vertically, and runs upon a bed that is cast integral with the base. The base is made very broad and heavy, and it is claimed that much of the vibration incident to operation is absorbed in this heavy base. Adjustment for depth of cut is secured by moving the cutter-

head vertically on its bearings on the column by operating the pilot wheel at the front of the machine. Lateral adjustment is made by moving the cutter-head column in or out from the table on ways on the machine base, this adjustment being controlled by the operation of the handwheel beneath the table. The table of the milling machine is traversed by a lead-screw that receives motion through a worm and worm-wheel, leading back to the driving mechanism. The table has a maximum longitudinal travel of 4 feet, and automatic stops are provided to limit the movement in either direction. A handwheel at the extreme right-hand end of the machine provides for traversing the table by hand.

The entire operation of the machine is controlled from driving pulley A, which may be seen near the center of the machine. Rotation is carried back to shaft B, and thence down to a secondary driving shaft C that terminates, as may be seen in Figs. 1 and 4, in a bevel gear D. This bevel gear transmits motion to worm-shaft E that carries power to the worm-wheel F which operates the carriage through a lead-screw. From the opposite end of worm-shaft E, a spur gear carries rotation through a set of change-gears to the worm-shaft G that operates the work-holding spindle. This mechanism may best be seen by referring to Fig. 1 in connection with the line illustration Fig. 4.

From the main driving shaft, rotation is carried to the cutter-head as shown in Fig. 3 by a universal joint connection H. By means of gearing, motion is carried from this universal joint shaft to the cutter-arbor, and at the same time a speed reduction is made in the ratio of 9 to 1. On the cutter-head is a bevel pinion that receives rotation from the small bevel pinion I, and transmits it through the larger pinion J. This arrangement permits the cutter-arbor and gearing to be swiveled to any angle in the horizontal plane. From the shaft on which gear J is mounted, a spur pinion meshes with another spur gear that carries rotation down to the cutter-arbor. From worm-shaft E, brackets support the spindle worm-shaft

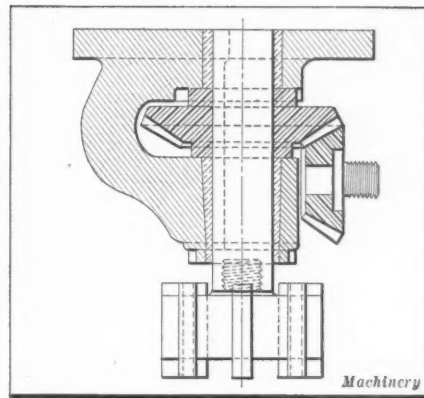


Fig. 2. Cross-sectional View of Vertical Cutter-head shown on Machine in Fig. 1

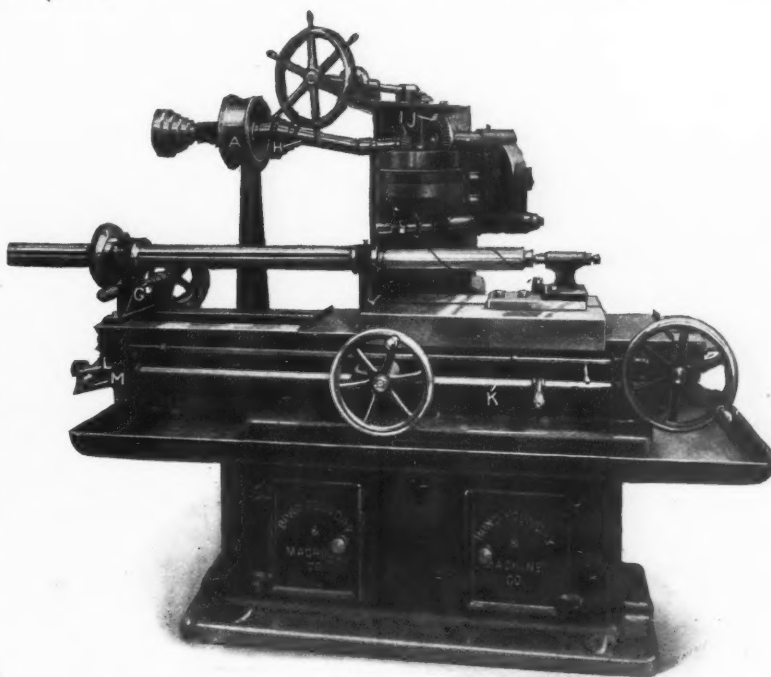


Fig. 3. Bowen Milling Machine set up for milling a Helical Groove

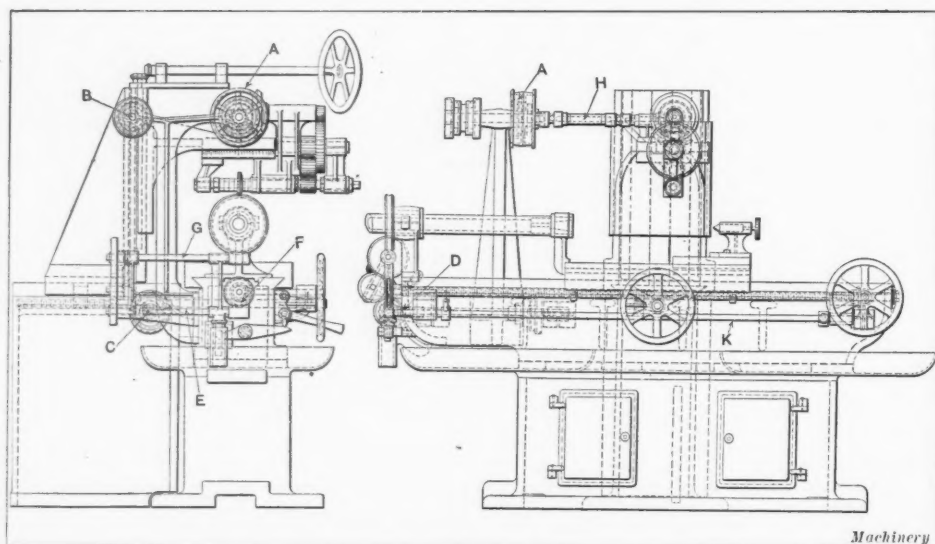


Fig. 4. End View and Front Elevation of Bowen Milling Machine

G, and when the worm on the lower shaft is disengaged, the upper one also is disengaged. The worm-disengaging mechanism is operated through a hand-lever on rod K at the front of the machine. The rocking of this shaft causes finger L to operate lever M and thus raise or lower the two worm-shafts to engage or disengage the two worms.

By making the proper changes in the spur gears at the rear of worm-shaft E, a helical groove may be cut of any desired pitch from a keyseat to the finest thread. It is obvious that the work-holding spindle may be fitted with any form of chuck or faceplate, and that the table is provided with a tail-center for supporting long work. Fig. 1 shows the machine set up with a vertical attachment on the cutter-head for face-milling; and the design of this cutter-head may be seen in Fig. 2 which illustrates this mechanism in cross-section. The

num simplicity and strength at points where there is danger of breakage. For example, the tips are enclosed within the head, which eliminates exterior leakage and resulting danger of damage from the leaking gases taking fire.



Fig. 2. "Hoover" Torch with Head mounted in Straight Position

SOUTHWICK DUCK-CENTER CHROME BELT

The George W. Southwick Co., Stamford, Conn., has recently added to its line of power transmission specialties the "duck-center" chrome leather belt illustrated and described herewith. It will be seen that this belt consists of two thicknesses

of chrome leather with a strip of duck between them, and the entire belt is glued together in such a way that it is guaranteed not to stretch, come apart or be impaired by the action of water or oil. It is claimed that this belt grips the pulley more tightly, and on this account is able to transmit 25 per cent more power than a standard leather belt of the same size. The center is reinforced with 48-ounce duck which is said to add 40 per cent to the strength of the belt. It is also stated that this belt runs just as true as any other kind of belt, and that the duck center makes it extremely flexible; consequently, it is well adapted for use on high-speed machinery. It is made in single and double thicknesses.

In making this belt, the duck center is first stretched to its utmost capacity, and while under tension the leather is cemented to it. After the cement has dried, the tension is released; and in this way it will be evident that the duck center takes all the strain when the belt is under load. It is this condition that enables the belt to cling so tightly to the pulley. In order to demonstrate the waterproof qualities of the belting, it is stated that a sample was boiled for twenty-four hours, after which it was removed



Duck-center Chrome Leather Belt made by George W. Southwick Co.

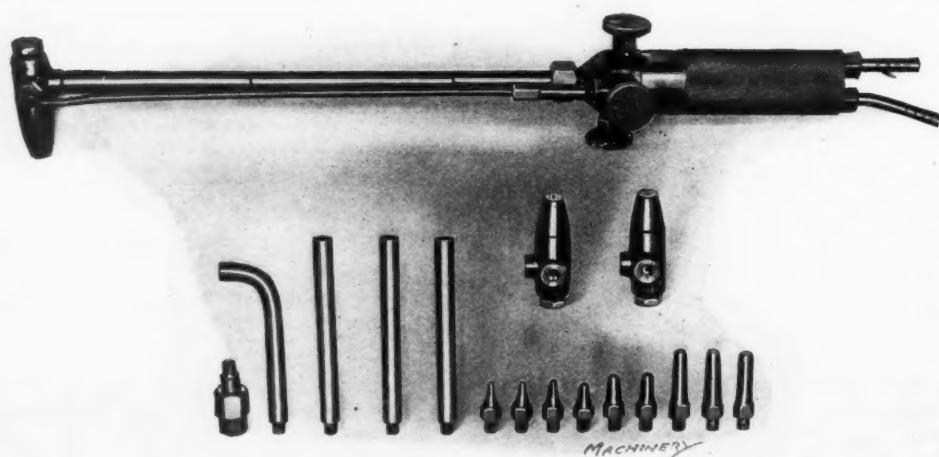


Fig. 1. "Hoover" Torch with Head mounted in Right-angle Position

drive is from the same spindle that operates the cutter when working on thread milling. Rotation is received from the bevel gear on the right-hand side, as viewed in Fig. 2, and meshing with this pinion is a bevel gear on the vertical cutter-spindle. Cutters up to 10 inches in diameter may be used.

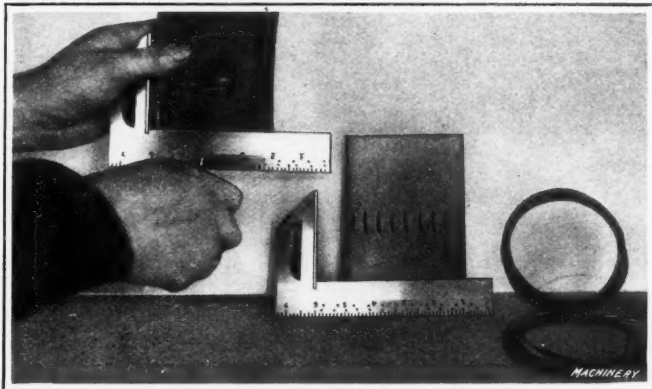
"HOOVER" COMBINATION WELDING AND CUTTING TORCH

The Oxy-Acetylene Products Co., 810 Diversey Parkway, Chicago, Ill., has recently placed on the market a combination oxy-acetylene torch which is adapted for the welding and cutting of all metals. A feature of this torch is that it may be adjusted to adapt it for welding work of a great variety of sizes; and the torch may be easily changed to make it suit-

from the water and dried, and subsequent examination failed to reveal that the strength of the cemented joint had been impaired in any way.

SOUTHWICK BELT TEMPLET SQUARE

In the April, 1913, number of MACHINERY, a description was published of the twisted rawhide belt lacing which had just been placed on the market by the George W. Southwick Co. Subsequent experience in the use of this belt lacing has shown that it is highly important to have the holes correctly spaced and located at just the proper distance from the end of the belt. To facilitate laying out these holes, the George W. Southwick Co., Stamford, Conn., has recently placed on the market a combination templet and square which is illustrated here-



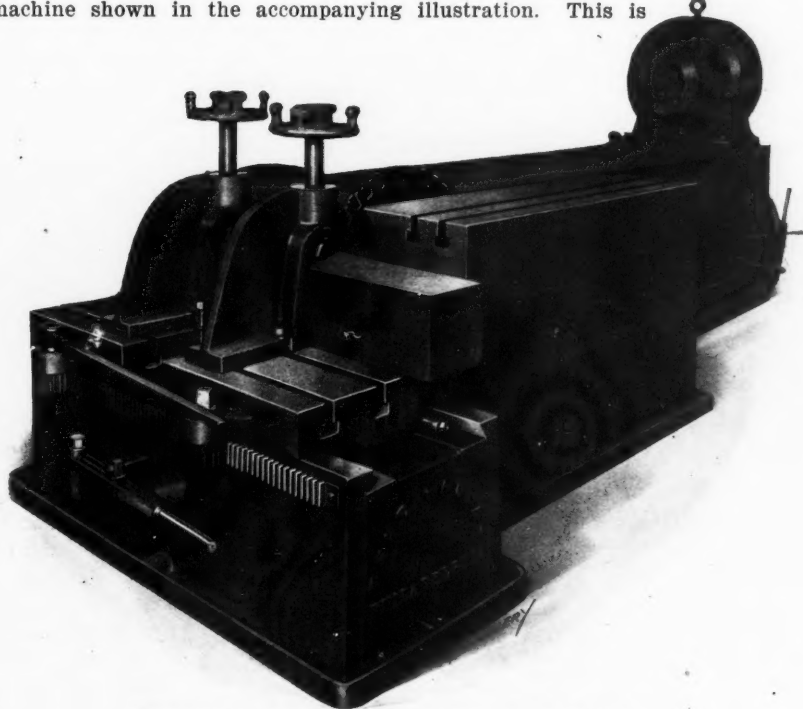
Templet Square for spacing Holes for Twisted Rawhide Belt Lacing

with. The use of this tool is made apparent from the illustration, so that further description is unnecessary; and it will be apparent that in using a tool of this kind there should be absolutely no excuse for failure to obtain exactly the required location and spacing for the lacing hole.

ESPEN-LUCAS BILLET SLITTING SAW

In the manufacture of steel bars, the best practice is to slit the rough billets into quarters and then forge these quarters into bars of the required shape. This obviates danger of carrying a "pipe" down with the billet and thereby leaving every bar with a flaw. By the billet slitting method the "pipe," if there is one, is left on the outside of the stock where it will be removed by subsequent machining operations.

For the rapid slitting of steel billets, the Espen-Lucas Machine Co., Philadelphia, Pa., has placed on the market the machine shown in the accompanying illustration. This is



Billet Slitting Cold Saw built by the Espen-Lucas Machine Co.

really a combination machine, as in addition to being used for slitting billets, it may be used as a regulation cold saw. The inserted-tooth blade that the machine carries is 48 inches diameter and extends 14 inches above the table on which the billets are held. The saw has a travel of 8 feet, so that it can slit a billet 14 inches in diameter by 8 feet long at one cut. It is driven by a twenty-five-horsepower variable-speed motor. From the motor, a belt drive transmits power to a worm and worm-wheel, and then to the saw arbor.

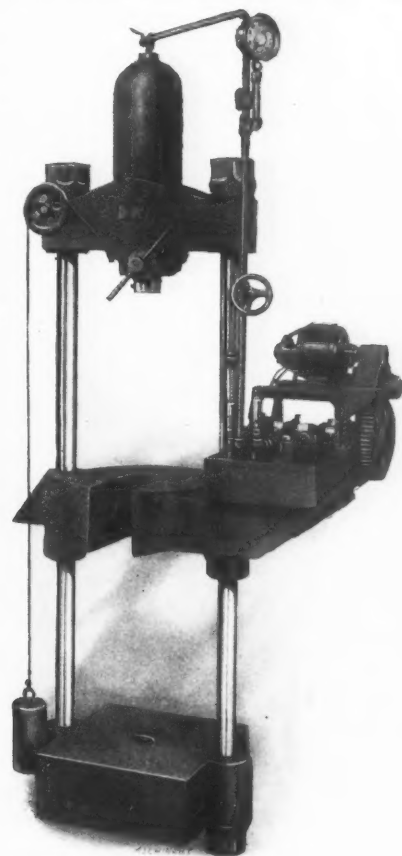
The feed is at the rate of $1\frac{1}{2}$ inch per minute, when the saw is cutting at a depth of 14 inches, and is secured through the Espen-Lucas type of friction plate, both plates being of the same size. The machine may be controlled from the front by means of a lever that may be seen on the side of the machine, or from the rear, making it convenient for the operator. Automatic stops are provided to disengage the drive at any desired point. All gears are adequately covered. The machine weighs approximately 50,000 pounds.

INVERTED HYDRAULIC FORCING PRESS

The inverted hydraulic forcing press illustrated and described herewith is a recent product of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. It was especially designed to meet the requirements of two distinct forcing operations, i. e., for forcing locomotive piston rods into piston heads, and also for removing the piston heads from the rods. However, it can readily be seen that the press is suitable for handling a variety of other work of this kind. In addition, this press is suitable for the performance of certain classes of arbor and broaching operations, the open slot of the upper base allowing ample space for the arbor or broach to pass through the work.

For forcing on a piston head, the head is set on the lower base with the rod passing up through the slot in the upper base, after which the pressure is applied to the end of the rod, thus forcing it into the piston head. When the press is used for forcing the piston head off the rod, the head and rod are hung on the upper base and the pressure is applied at the upper end of the rod, thus forcing it out of the head. More pressure is required for this operation, and so the upper part of the press is designed for a maximum pressure of 100 tons.

The forcing of the rod into place in the head does not require so much pressure, and so the lower portion of the



Inverted Forcing Press built by Hydraulic Press Mfg. Co.

press is designed for a maximum pressure of 50 tons, which is ample for handling this class of work.

The usual method of installation is to erect the press so that the upper base is just above the floor level, with the lower base under the floor. The press is self-contained, pressure being furnished by a direct-connected motor-driven horizontal double-plunger pump, with a double gear reduction. A T-screw hydraulic operating valve controls the pressure of this pump to the press cylinder. The diameter of the ram is 10 inches, and it has a run of 22 inches; the ram is equipped with a rack and pinion attachment for raising or lowering it to the work. In this way various lengths of work can be admitted to the press and the pressure can be instantly applied at the first stroke of the pump. The "daylight" space for the upper portion of the press is 36 inches, and for the lower part 50 inches, making the total "daylight" or working space 86 inches.

WARREN "HYDRAULIC" LATHE FOR LARGE SHELLS

This machine is intended for the performance of external operations on shell forgings as large as 9 or 10 inches in diameter. The turning tools are carried on a pivoted holder which may be swung to provide for generating the pointed nose of the shell. The work-spindle is moved axially by the pressure of oil in a cylinder to provide for feeding the work to the tools; and the cutting-off tools are also fed by oil pressure in cylinders at the front and back of the lathe. The machine is designed for heavy work and is provided with ample power to drive high-speed steel cutting tools to the limit of their cutting capacity.

The Warren "hydraulic" lathes built by the Lombard Governor Co., Ashland, Mass., for turning small shells were described in the February and May numbers of MACHINERY. Another form of this lathe has now been put on the market which is intended for exterior operations on shell forgings as large as 9 or 10 inches in diameter. As in the previous forms of this lathe, the thrust of the revolving spindle, which has a minimum diameter of 9 inches, is taken wholly by oil under pressure, so that as far as the end thrust is concerned the spindle is practically frictionless. The oil which absorbs the end thrust also provides a hydraulic feed for the spindle which travels axially. The cutting-off tools in this new form of lathe are also fed hydraulically,

so that the machine is very nearly automatic and consequently "fool-proof."

Fig. 1 shows a partial end view of the machine as one looks down at it. The total length is 12 feet, width, 50 inches, height, 56 inches, and approximate weight, 8000 pounds. Shell forging A, in this case 8 inches in diameter, is clamped by a hydraulically expanding arbor approximately 5 inches in diameter, which, in itself, is drawn into the 9-inch spindle by the same hydraulic pressure which provides the clamping action. In consequence, the mounting of the forging is so rigid that it is entirely unnecessary to provide

any support at the outer end, and the heaviest chips can be taken without appreciable vibration. The drive to the spindle is from the pulley B through a hydraulic clutch controlled by the three-way valve C, Fig. 2, the double back-gear giving a ratio of 21 to 1.

The heavy tool carrier D swings about a vertical pivot E and is mounted upon a trunnion F; consequently, the tool carrier can be lifted up so as to throw the tools entirely out of contact with the work, as shown in Fig. 2, which is necessary when forgings are being put onto or taken off the expanding arbor. The tool-holder D carries two heavy tools at G and H; and the outer end of carrier D is slotted so as to pass over a swiveling block I which travels on ways through the movement of the hydraulic piston K that is controlled by the graduated needle valve L. This provides an extremely convenient and infinitely adjustable method of feeding tool carrier D. As tool carrier arm D swings around pivot E as a center, tool G generates the curved nose of the shell, and tool H is out of action; but when piston K reaches the forward limit of its travel, as it comes up against a solid abutment, tool H is forced into the revolving shell.

While the nose of the shell is being generated by tool G, tools actuated by two cutting-off cylinders M and N (the latter not clearly shown in Fig. 1) are at work trimming off the large end of the shell. This cutting-off operation proceeds very rapidly, and as soon as it is completed the pistons automatically back out the tools. As soon as the nose of the shell is

finished through the action of the swinging arm D, piston K feeds forward until it comes up against its abutment, and simultaneously throws over control lever O which starts the main spindle of the machine moving forward. Consequently, the two tools H and G which are now held sta-

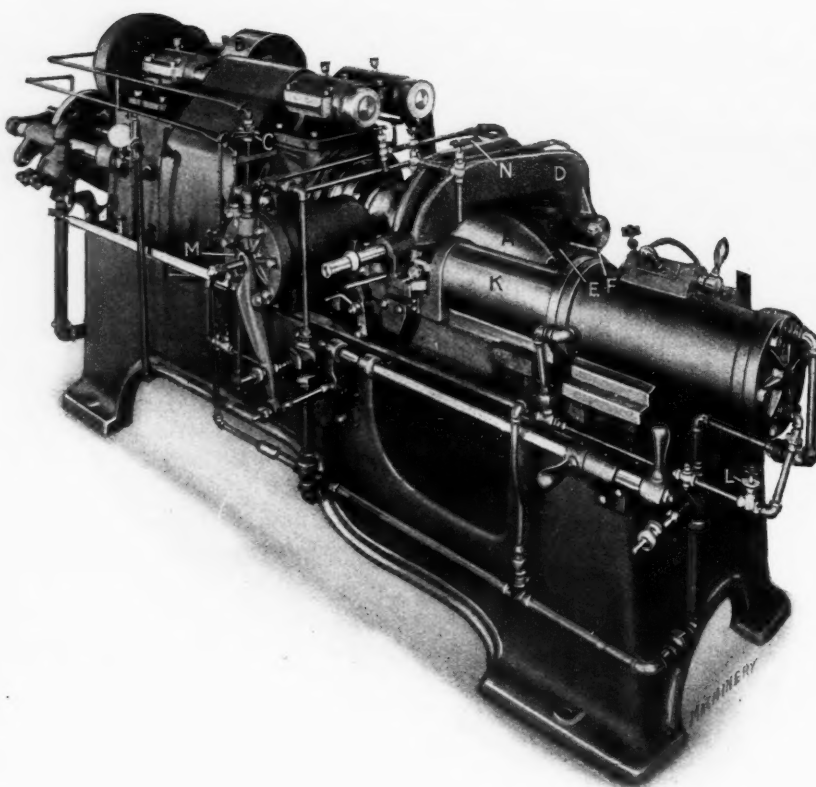


Fig. 1. Partial End View of Warren "Hydraulic" Lathe for Large Shells

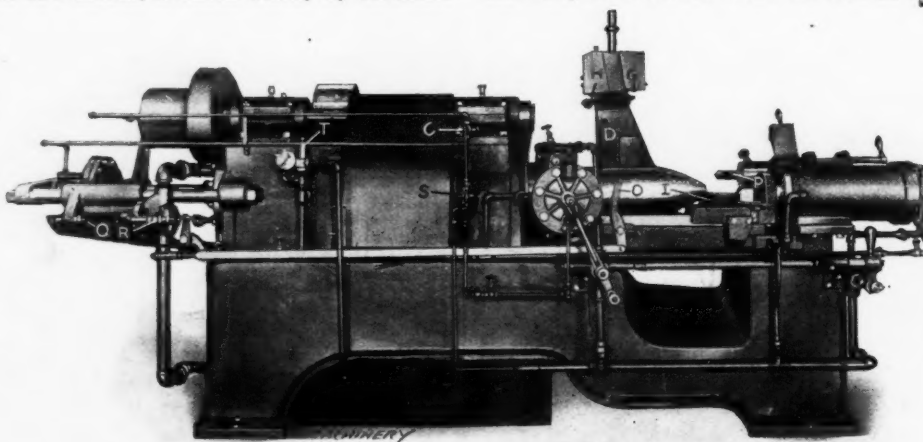


Fig. 2. Front View of Machine with Tool Carrier lifted to throw Tools out of Contact with Work

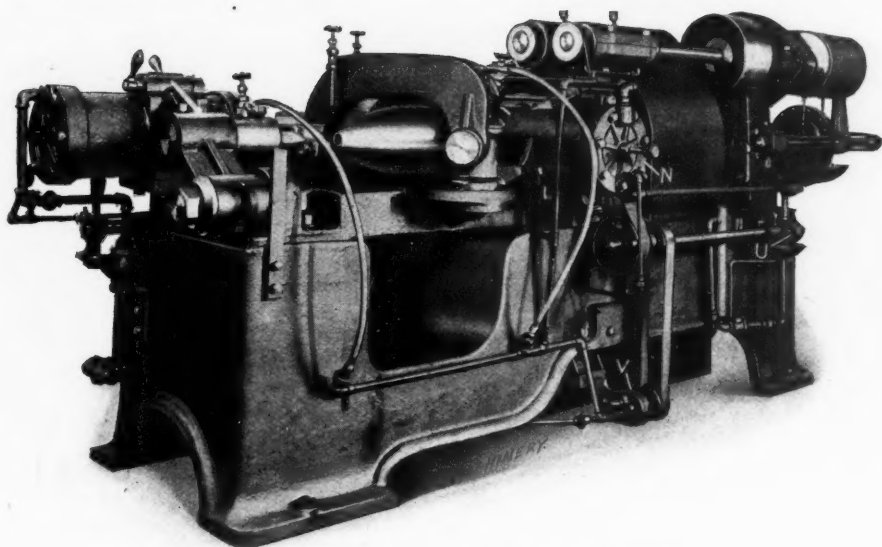


Fig. 3. Rear View of Machine, showing Oil Pumps U and V

tionary turn the cylindrical surface of the shell. At the same time, drill *P* which has been swung down into a position in line with the center of the shell forces its way through the nose of the forging. When the main spindle of the machine reaches the end of its forward travel, the stop-screw *Q* actuates the discharge valve *R* and the operator after moving the clutch valve *C* one-fourth turn lifts the arm *D* into the position shown in Fig. 2 and removes the forging from the spindle after it has been released by turning valve *S*.

All the feeds on the machine are controlled by graduated needle valves, and they may be instantly changed from 0 to $\frac{1}{4}$ inch or more per revolution. No harm can result if the point of a tool fails, because there are no gears or complicated feed mechanism to break. In such a case the hydraulic pistons will merely exert their full pressure, which is limited by the relief valve *T*. The frame of the machine and the main spindle bearings are cast integral, and the whole structure is so rigid that it is free from vibration on any kind of foundation. The power of the machine is limited only by the endurance of the tools. Cuts can easily be taken which will overheat the best quality of high-speed steel.

The oil supply for the operation of the machine consists in a small rotary pump on the back of the machine at *U*, Fig. 3, while the supply of cutting compound is furnished by another rotary pump at *V*. The supply of oil furnished by the latter is piped to all the tools. An end view of the machine is shown in Fig. 4. It is estimated that thirty horsepower should be provided to operate this powerful lathe to its full capacity. The diameter of pulley *B* is 12 inches, the face width 7 inches, and the speed, 600 revolutions per minute. It is believed that this semi-automatic lathe is capable of giving exceptionally satisfactory results on large forged shells, by removing the metal rapidly and by performing several operations simultaneously.

NEW MACHINERY AND TOOLS NOTES

Micrometer Caliper: L. S. Starrett Co., Athol, Mass. A micrometer made for the Union Twist Drill Co. for use in measuring three-fluted tools such as drills, taps, cutters, etc. The anvil of the standard micrometer is replaced by a 60-degree V-block to enable it to handle work of the kind referred to.

Bench Grinding Machine: Grayson Tool & Mfg. Co., Indianapolis, Ind. A bench machine especially adapted for grinding dies, punches, gages, etc. The machine has a table 12 by 14 inches in size with suitable provision for feeding the work to the wheel. The overhead works are supported by a pipe stand reaching from the bench to the ceiling.

Hand Screw Machine: Loisy-Patton Co., Cleveland, Ohio. A hand screw machine, the design of which follows standard practice in the construction of machines of this type. It has a capacity for handling bar stock up to 1 inch in diameter, and work can be turned up to 6 inches in length. The swing over the bed is 14 inches, and over the cut-off slide, 6 inches.

Tool-holder: Worcester Flexible Tubing Co., Worcester, Mass. A tool-holder suitable for use on lathes, planers,

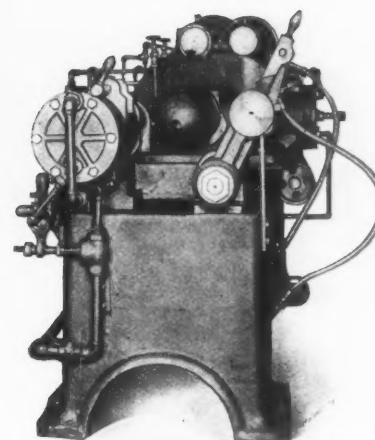


Fig. 4. End View of Warren "Hydraulic" Lathe for turning Large Shells

shapers, etc., in which the cutter is supported right out to the edge. No set-screws are used on the tool-holder, and the construction is such that the possibility of breaking the cutter or holder is said to be reduced to a minimum. The holder can be used either right-hand or left-hand.

Thread Miller: Edwin Harrington, Son & Co., Inc., Philadelphia, Pa. A thread milling machine designed for handling general work such as milling screw threads, helical slots and spiral gears of either right- or left-hand. The work may be of fine or coarse lead, and either single or multiple. The work is gripped in a chuck at one end and supported by a steady-rest at a point directly beneath the cutter.

Multiple Toolpost: Rex Mfg. Co., Hyde Park, Boston, Mass. To meet the requirements of turning operations where multiple cutting tools are used, the "Rex" multiple toolpost has been placed on the market. The toolpost is so constructed that several can be placed side by side in the tool-block, and no change is required unless it is necessary to use more toolposts than there is room for in the tool-block.

Facing Head: Mummert-Dixon Co., Hanover, Pa. A facing head made in 6-, 9-, and 12-inch sizes. These heads can be used in connection with a bar on any machine that will hold and drive a bar supported on centers. The heads can also be used without a bar, in which case they are mounted on a tapered shank fitted into the end of the spindle. The head and its feeding arrangement are a self-contained unit.

Band Seat Turning and Waving Machine: Traylor Engineering & Mfg. Co., Allentown, Pa. This machine is especially designed for use in turning and waving the band seat in six-inch shells. It is equipped with an air chuck which has ample power to hold the shell securely during the machining operation. The floor space occupied is 6 by 4 feet, and the weight of the machine, approximately 9000 pounds.

Four-jawed Chuck: Mann Corporation, Chicago, Ill. A heavy-duty four-jawed chuck designed to meet the requirements of work which calls for the use of a four-jawed direct screwed chuck with a large hole and small range of jaw travel. The chuck is said to be especially adapted for use on heavy cutting-off machines, and for gripping shrapnel or high-explosive shells of all sizes during the performance of various machining operations.

Heavy-duty Lathe: Houston, Stanwood & Gamble Co., Cincinnati, Ohio. A heavy-duty high-power lathe, equipped with an all-g geared headstock and single pulley drive. The tailstock is of the offset type and provided with the adjustable set-over feature to provide for handling tapered work. The swing over the carriage is 30½ inches; swing over the bridge, 19 inches; distance between centers, 72 inches; and weight of the machine, about 13,000 pounds.

Direct-reading Ohmmeter: Roller-Smith Co., 203 Broadway, New York City. A direct-reading ohmmeter for portable service; the instrument was especially designed for use in measuring the resistance of relay points in electric signaling systems. It consists of a slide wire bridge with a self-contained galvanometer of sensitive but rugged design. The instrument is packed in a hardwood box which enables it to be conveniently carried from place to place.

Multiple Punching Machine: Hilles & Jones Co., Wilmington, Del. The machine is designed for use in the manufacture of mine screens and other perforated work of a similar nature. The space between the housings is 62 inches; the machine is equipped with an automatic spacing table, and it has sufficient capacity to punch thirty-five holes 1½ inch in diameter through a ¼-inch mild steel plate, or fourteen holes of the same size through a steel plate ½ inch in thickness.

Electric Hoist: Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The design of this hoist follows that of the preceding model of this company's manufacture. The chief point of difference is in the gear construction; the gears on the new hoist are heat-treated in order to increase their durability and strength. The hoist frame consists of two cylindrical castings which are flanged and bolted to each other at the center of the hoist. The motor is of the standard series-wound, slow-speed type.

Rifle Barrel Drilling and Rifling Machines: International Engineering Co., Cleveland, Ohio. A deep drilling machine and a rifling machine for use in drilling the holes and cutting the rifling grooves in rifle barrels. The drilling machine is of the duplex type and provides for drilling two rifle barrels at a time. The rifling machine works on one barrel at a time. On the rifling machine, the bar is moved along the bed by a lead-screw and the work is indexed by a cam and dog mechanism after each stroke of the cutter-bar has been completed.

Automatic Screw Machine: Chicago Automatic Screw Machine Co., Chicago, Ill. This machine is driven by a single belt from the lineshaft so that the use of a countershaft is unnecessary. It is equipped with a turret $7\frac{1}{2}$ inches in diameter, and either four or five holes may be provided in the turret. The spindle capacity is for work up to 2 inches in diameter. The floor space occupied by the machine is 36 by 124 inches, and its approximate weight is 3450 pounds. The John Macnab Machinery Co., 90 West St., New York City, is selling agent for this machine.

* * *

CORRECTION

In the May number of MACHINERY a description was published of two turret heads made by the Newman Mfg. Co., 717 Sycamore St., Cincinnati, Ohio. In describing the lathe turret, the statement was made that it is intended for use on the tail-stock spindle; but this was incorrect, as the turret is intended for use on the toolpost of the lathe. Also, it should be noticed that this toolpost turret provides a series of four tools instead of five, as stated in the description published in the May number of MACHINERY.

* * *

THIRD NATIONAL EXPOSITION OF SAFETY AND HEALTH

The Third National Exposition of Safety and Health which was held under the auspices of the American Museum of Safety at the Grand Central Palace, New York City, May 22 to 27, inclusive, contained exhibits of the widest imaginable scope, ranging from the safety of infants to national safety through preparedness. Among the most numerous and most elaborate exhibits were those of various railroad companies, whose exhibits included examples of safety applied to railroading in all of its many stages. Some of the lesser exhibits included safety gasoline cans, safety matches, safety eye goggles, safety mining lamps, safety stair treads, safety electric lamp lowerers, safety belt lacing, safety elevator locks, safety fire extinguishers, safety set-screws, and safety mechanical stopping devices for machinery. Other exhibits which came under the head of either safety, sanitation or health were bubbling drinking fountains, sanitary towels, malted milk, disinfectants, life-saving devices, and insurance.

One exhibit deserving mention as applying more directly to the machine tool building trade, was that of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Among the various articles exhibited were chipping screens, milling cutter guards, punch press guards, punch press feeders, compressed air press ejectors, magnetic press feeders, safety insulated screwdrivers, safety babbitt ladles, safety acid jug, safety foot press requiring both hands to release the ram before it can be operated by the foot, circular saw guards of several types, and safety ladder.

By far the largest exhibit was that of the United States Army and Navy representing the various phases of military life, aiming to show how national safety may be insured through preparedness.

* * *

HEALTH INSURANCE

The American Association for Labor Legislation, New York City, has been instrumental in introducing bills for health insurance in the legislatures of Massachusetts, New York and

New Jersey. These bills differ in principle in one important respect from the report just adopted by the National Association of Manufacturers in regard to the carrying agency. Those responsible for drafting the bills thought it essential that the normal insurance carrier should be a mutual association of employers and employees under their joint control and organized according to trade or locality. By this method a workman is automatically insured in the fund for his own trade, or if there is no such fund, he is insured in the local fund for his district, and thus the costly process of acquiring business, inherent in the present industrial insurance, is eliminated. The economies of this system of administration are evident. Since the funds designed in these bills to carry insurance are under the control of employer and employee who are contributing to the fund and receiving the benefits, there will not be the same temptation to extravagant administration so often charged against state-managed enterprises. For this reason the often alleged necessity for competition with state-controlled insurance is not valid. The acceptance of the principle of compulsory health insurance and the distribution of the cost in relation to the responsibility for sickness by the manufacturers' associations are encouraging signs of industrial betterment. Health insurance is in the same class of industrial betterment as "Safety First" and related movements to eliminate danger to life and limb.

* * *

BULLARD "MAXI-PAY" PLAN

The Bullard Machine Tool Co., Bridgeport, Conn., has adopted a "Maxi-pay" plan for its employees which is described in a statement distributed to the men May 13, as follows:

Skill and proficiency are the actual foundations of low cost of production—not a low hourly wage rate. Skill at the machinist's trade may be acquired by years of application in any of a thousand shops, but proficiency in the construction of a highly specialized product like ours can be obtained only by long association with that product, through which may be developed a knowledge of its working and appreciation of the exacting requirements of the construction of the various details which enter into it. The longer a man is with us, the better is his worth, because of his development in skill and his greater knowledge of the special needs of the building of our machines. In the final analysis, that man's work costs less; even though his hourly wage is considered high, because of his superior quality and the greater efficiency with which it has been produced.

Our "Maxi-pay" wage plan has been developed from these basic facts. It recognizes the value of skill and proficiency and provides suitable rewards for their attainment. It presents a high mark for the good men to aim at and opens the doors of opportunity for advancement to all in our employ—even to those who are now unskilled.

By close personal study of the individuals in our organization and a careful inspection of their records, E. P. Bullard, Jr., our president, in conference with the shop executives and foremen has grouped the men into six distinct classes, four of which cover the mechanics, one the apprentices, and one the non-mechanical and unskilled members of our force. Future advancement will be made the subject of an equally fair and careful consideration.

In class AA, from which will be recruited our future shop executives and foremen, are grouped the sub-foremen and leaders in charge of the working gangs of mechanics. The maximum wage rate is limited only by ability, facility and occupation, while a high minimum of 55 cents per hour has been set.

Class A, comprised of the mechanics of highest skill, forms the basis of promotion to class AA, and like it has an unlimited maximum hourly rate dependent only on ability, and a minimum rate of 50 cents an hour.

Mechanics of good average ability are rated in class B, for which a wage of 45 cents per hour has been set. Advancement in grade will be the logical reward of proved merit and diligent service.

In class C have been grouped those mechanics of lesser skill but who by their records show merit and possibilities of development which will warrant advancement to the highest class. The hourly rate is 40 cents.

All apprentices, both special and regular, are put in class D, and when their term expires promotion will be promptly made to the classification for which they have qualified. The apprenticeship rates are advanced approximately 10 per cent.

The non-productive skilled labor and the unskilled labor, such as truckers, cleaners, sweepers, etc., have been grouped in class E which has a minimum rate of 25 cents an hour, and a maximum which is limited only by occupation and

skill and proficiency therein. In recruiting this force, preference will be shown to those who can speak and write the English language and who show possibilities of advancement and development.

To the unskilled there is offered the opportunity to acquire skill with the regular or special apprenticeship courses. Our aim and hope is to have a mechanical organization composed mainly of AA and A men, with B, C and D men in sufficient numbers only to provide for natural growth and expansion and to make up the small losses that are bound to occur in any large organization.

As a further incentive to continued regular attendance, we will maintain our continued service bonus payment of 10 per cent of the full weekly wage. This is in no sense a part of the hourly rate, nor is it considered by us as a wage payment. It is a distinct reward for regular and continued service and is made possible only by the fulfillment of a production schedule which could not otherwise be maintained.

Bridgeport, Conn.

BULLARD MACHINE TOOL CO.

Several months ago the company adopted the eight-hour workday and placed its plant on a twenty-four hour schedule, working three shifts, eight hours each. The further adoption of the "Maxi-pay" plan, so called because no limit is placed on earnings, places the company in the front rank of liberal and cooperative employers. The innovation, if such it can be named, will be watched with the keenest interest.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for April 1, 1916.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, The Industrial Press 140-148 Lafayette St., New York
Editor, Fred E. Rogers
Managing Editor, None
Business { Alexander Luchars, President " " " "
Managers { Matthew J. O'Neill, Gen'l Manager " " " "
2. That the owners of 1 per cent or more of the total amount of stock are:
The Industrial Press 140-148 Lafayette St., New York
Alexander Luchars " " " "
Matthew J. O'Neill " " " "
Fred E. Rogers " " " "
Louis Pelletier " " " "
Erik Oberg " " " "

3. That there are no bondholders, mortgagees or other security holders.
4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 22nd day of March, 1916.

FRANK J. SCOTT,

Notary Public, No. 321, Kings County.

(SEAL)

Certificate filed in New York County No. 247.

(My commission expires March 30, 1917.)

PERSONALS

John S. Rountree has taken the position of advertising manager of the Searchlight Co., Chicago, Ill., succeeding Grover Clark, resigned.

H. B. Hoover, formerly manager of the Turner Brass Works, Sycamore, Ill., is now general manager of the Oxy-Acetylene Products Co., Chicago, Ill.

J. W. Lee, Jr., publicity agent of the Pennsylvania Railroad, has resigned the position and will move to New York City, where he will be associated in business with Ivy L. Lee.

Grover Clark has resigned his position with the Searchlight Co., Chicago, Ill., to take the position of advertising and sales manager for Ludwig & Ludwig, of 2427 W. 14th St., Chicago, Ill.

S. S. Buckley, who for the past five years has been in charge of the tool steel sales of the Bethlehem Steel Co., has been made president of the newly organized Onondaga Steel Co., Syracuse, N. Y.

John J. Cruice, for the past eight years representative for Edgar Allen & Co.'s high-speed and carbon steels, has been appointed Detroit representative for the Haynes Stellite Co. of Kokomo, Ind.

R. T. Lane, general sales manager of the Standard Tool Co., Cleveland, Ohio, delivered a lecture with stereopticon views

in Passaic, Monday evening, May 15, on the "Uses and Abuses of Cutters, Drills, Taps, Reamers and Other Tools."

E. D. Newkirk, formerly superintendent of the Rome Wire Works, Rome, N. Y., and later secretary and general manager of the Marvin & Casler Co., Canastota, N. Y., has been made secretary and treasurer of the Onondaga Steel Co., Syracuse, N. Y.

D. M. Crossman, who for some years has been an assistant in the department of publicity of the Niles-Bement-Pond Co., New York City, has been made manager of publicity, succeeding H. M. Cleaver, who has been transferred to the Pond Works at Plainfield, N. J.

Joseph E. Vincent, Jr., for a number of years connected with Wheelock, Lovejoy & Co., and the Swedish Iron & Steel Corporation, has been made general manager of the newly organized Iron, Steel, Metal & Alloy Co. of America, Liberty Tower Bldg., New York City.

W. S. Quigley, president of the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City, read a paper before the Philadelphia Foundrymen's Association, May 3, entitled "Tests of High-temperature Furnace Cement," containing data useful to users and makers of high-temperature furnaces.

Henry Cave, president of the Cave Welding & Mfg. Co., Springfield, Mass., has associated himself with the Davis-Bournonville Co., Jersey City, N. J., and will have active charge of its research department. Mr. Cave will retain his connection with the Cave Welding & Mfg. Co.

Richard Martens, vice-president and managing director of R. Martens & Co., Inc., New York City, sailed May 16 on the California for Petrograd, Russia. During his six months' stay in America Mr. Martens completed the organization of his American company and studied the manufacturing industries here in relation to Russia as a future market.

F. L. Cone, who for more than twenty years was associated with the Windsor Machine Co., Windsor, Vt., for the past eleven years as general superintendent, has resigned and started in business for himself. He will build an automatic lathe, and has begun the erection of a shop 60 by 100 feet. The new concern will employ about 100 men at the start.

George H. Higgins has been appointed factory manager of the Burd High Compression Ring Co., Rockford, Ill. Mr. Higgins was formerly with the Stone & Webster Corporation, the Westinghouse Electric & Mfg. Co., Ford Motor Co., Buick Motor Co. and the Oakland Motor Car Co. Mr. Higgins will have general supervision over the factory matters and will give special attention to problems involving production.

Dr. Edward E. Pratt, chief of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, is the director of an educational course in foreign trade which has just been announced. The course is supplied to corporations and firms for study by their employees and to others interested in foreign trade. It is being issued through the Business Training Corporation with offices at 185 Madison Ave., New York City.

Oskar Kylin, for six years connected with the Warner & Swasey Co., Cleveland, Ohio, for the past few years as head designer, has taken a position with the Foster Machine Co., of Elkhart, Ind. Mr. Kylin was responsible for the designing and perfecting of the Warner & Swasey 2A and 3A turret lathes and the No. 4 universal screw machine now well known to the trade. He has also designed several other machines which are to be put on the market in the near future.

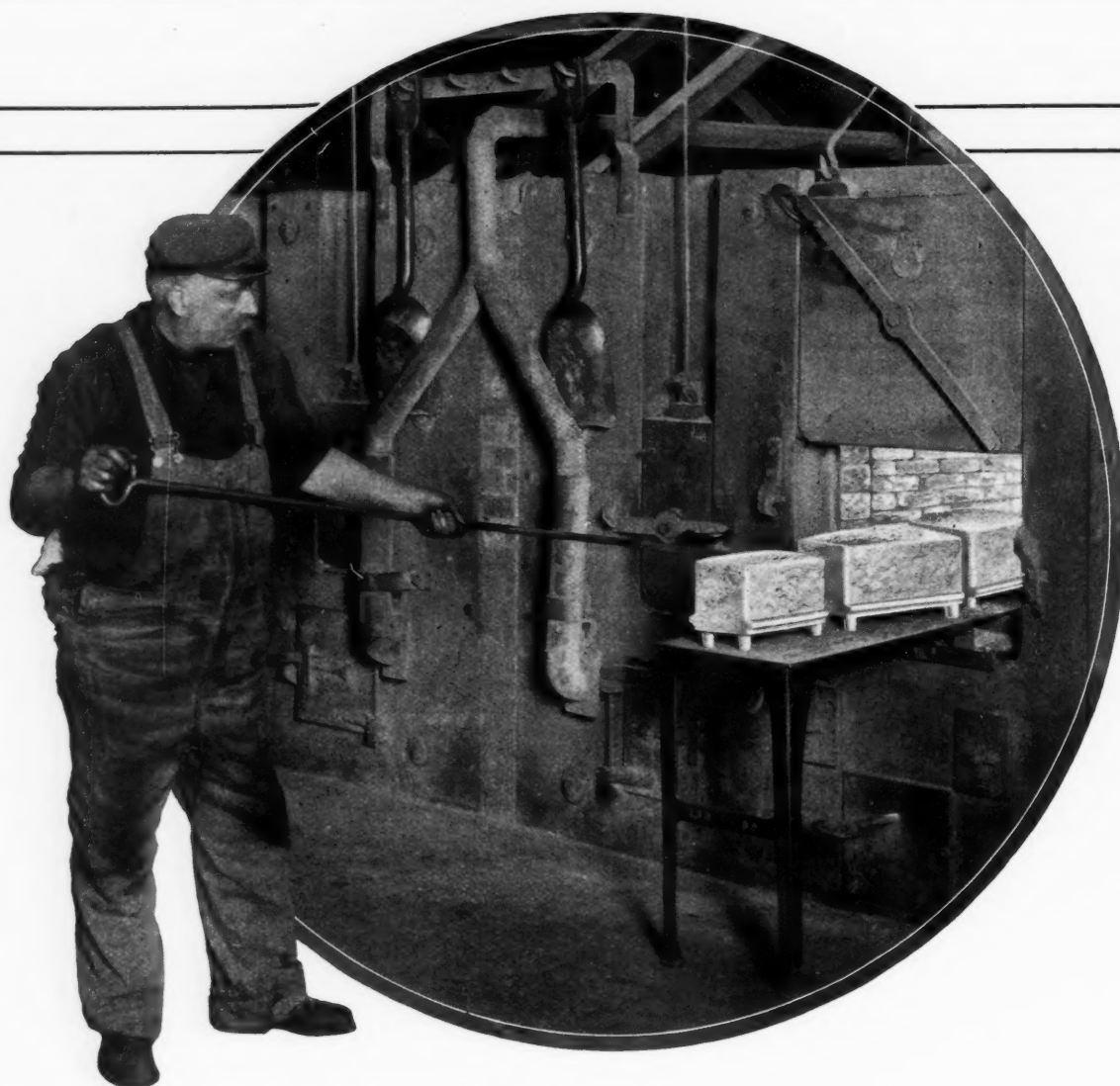
Joseph A. Horne was elected second vice-president of the Yale & Towne Mfg. Co., at a meeting of the board of directors held in April. Mr. Horne will retain his present position and title as general superintendent. He has been over twenty-four years in the company's service, and as general superintendent is responsible for the entire management of the Stamford works and of all the manufacturing operations of the company, including those of its Canadian plant at St. Catharines, Ont. His election as a vice-president is in recognition of his successful administration in the past, and of the ability that he has shown in discharging the duties of his responsible position.

OBITUARIES

Hugo Friedmann, a machine designer of considerable reputation and a contributor to MACHINERY, was killed in Detroit, Mich., February 20, by being struck by an automobile.

Rev. Dr. Josiah Strong, organizer and president of the American Institute of Social Service and founder of the "Safety First" movement, died April 28 in the Roosevelt Hospital, New York, aged sixty-nine years. Dr. Strong was associated with Dr. William H. Tolman in the early days of the safety movement and was active in founding what afterward became the American Museum of Safety.

Fred A. Welles, inventor of a friction adjustment for machinists' calipers, died at the home of his father, J. C. Welles, in Milwaukee, Wis., May 14, following an illness of a few days, aged fifty-two years. Mr. Welles was born in Milwaukee;



Scientific Heat Treating

requires, first of all, efficient equipment. To get high-grade, uniform and economical results furnaces are necessary that give an even, unvarying heat of the proper intensity with economy in fuel consumption.

Brown & Sharpe Case Hardening and Annealing Furnaces meet these demands. Designed and constructed on scientifically correct principles, they were developed for our large heat treating department where requirements are much more exacting in many cases than those of the average shop.

They are built to give little or no radiation. Steady, unvarying air pressure so essential to an even heat is readily secured and the temperature is easily controlled to suit the requirements of various classes of work. Write today for a special circular describing in detail

B. & S. Case Hardening and Annealing Furnaces





The Economy of High Quality

is strikingly apparent in using cutters. Inferior cutters may make an economical showing on an invoice but what is the verdict of the cost sheet and the production records? That's where *good* cutters show the difference. There are no frequent and protracted waits while they are being ground—no cutting down of speed and feed because of poor temper. They stand up well—keep your machines busy—and *produce*. So it pays to order high-grade cutters. Bear this fact in mind too—

The B. & S. Trade Mark is a Guarantee of Cutter Quality

so when your cutter orders read "Brown & Sharpe" you are sure of getting profitable results. We are proud of the confidence that trade mark inspires and we spare no effort to make sure that Brown & Sharpe Cutters meet expectations or surpass them. Every stage of manufacture is rigidly supervised. No detail is too small to receive expert attention—no cutter that fails to reach our high standard of quality leaves our works. That's why B. & S. Cutters make the strong showing in production results. Write for our new No. 136 Catalog—free.

Brown & Sharpe Manufacturing Co.

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after having secured an education in the public schools, he entered the E. P. Allis Co.'s Reliance Works, where he learned the machinists' trade. In early youth he showed great aptitude for things mechanical and built steam engines, boilers and other apparatus in his father's gun shop with remarkable ingenuity. The originality and skill displayed bordered on the marvelous, considering the age of the boy. He invented many things besides the friction adjustment for calipers, among which were an improved valve gear and governor, and a surface gage having novel features; in all, he made over one hundred inventions, but these were never patented owing to continued ill health. He placed the Welles caliper on the market in 1889. In 1894 he became greatly interested in the gas engine and built a number of different types. He was among the first to enter the automobile field, and built a car having several original features, such as the planetary gear, cantilever springs, etc. In 1905 he moved to Waukesha, Wis., where he took his tool business; but continued ill health forced him to dispose of the business to one of his former employees, A. J. Machek. With his passing, the world of mechanics has lost another master of tools, and one, like the late Dr. John E. Sweet, gifted with ability to make sound deductions and clear, comprehensive explanations of mechanical principles.

JOHN E. SWEET

John E. Sweet, president of the Straight Line Engine Co., past-president of the American Society of Mechanical Engineers, and one of the best known mechanical engineers in America, died at his home in Syracuse, May 8, aged eighty-three years.

He was born at Pompey, New York, in 1832, and his boyhood, spent on his father's farm, was given up to the varied work that a farmer's boy is called upon to do and to securing a common school education at the local schools of his native town. His mother, Candace Avery, was of the Avery family, which numbered among its members many able mechanics, among them the Avery who patented the first American steam turbine, which was one of the earliest turbines in the world to be put to any practical use. In 1835 several of these were in operation, one being used to drive a saw-mill at Syracuse, N. Y. It is probable, therefore, that young Sweet was by inheritance destined to become a machinist and engineer; and this in spite of his early training, which was in quite a different sphere. That he had a mechanical bent was early evident, one of his achievements as a boy being the construction of a violin, which so pleased his parents that he had the distinction of being sent to take violin lessons—a very unusual event at that time for a farmer lad.

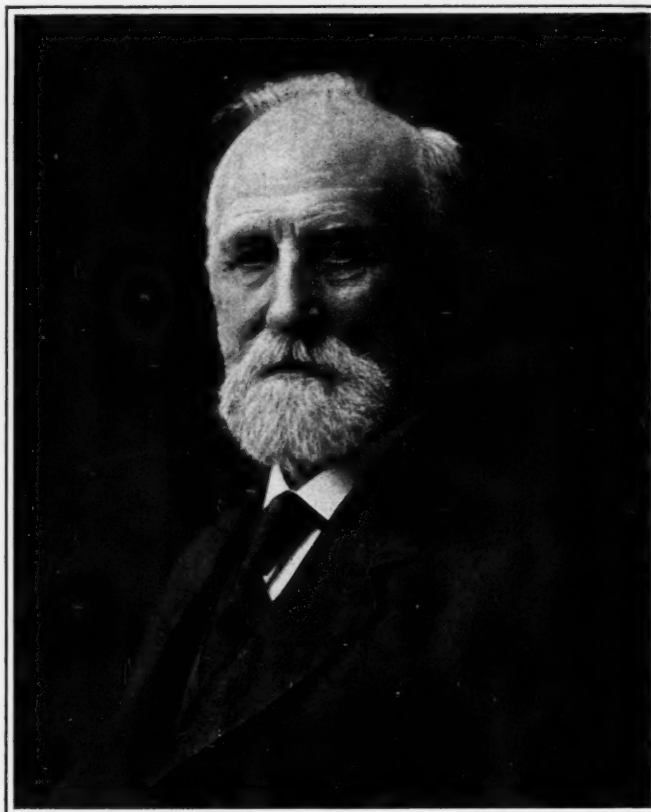
At the age of 18 he was apprenticed to learn the carpenter's and joiner's trade and his time was devoted to carpentry and building until nearly 30 years of age. After completing his apprenticeship he secured a position in the first architect's office opened in Syracuse conducted by Elijah T. Hayden, where he had an opportunity to become familiar with drawings of framed structures and building details. The laying out of such details passed for "architecture" in those days, since the artistic side of building design had not then received much attention, particularly in the smaller towns and cities.

The building plans of Sweet, the architect, bore the stamp of originality that characterized his later work. One of his most successful efforts, from a utilitarian point of view, was a set of plans for a model farm barn; and so great was the call for these that they were several times published in the *Rural New Yorker* and led to a series of articles in this publication by the young architect. His last work as an architect was in connection with the building of a hotel in Alabama, which was in process of construction at the outbreak of the Civil War. In common with many Northerners then in the South, he came North with the opening of hostilities. Later he went abroad, traveling in England and on the Continent, the immediate reason for his trip being the famous London Exposition of 1862. While abroad he contributed a series of letters to a Syracuse paper, showing him to be a versatile writer along popular as well as technical lines.

Singularly enough, the beginning of his mechanical career was made in England. He secured a patent on a nail machine in which the Patent Nut & Bolt Co., of Birmingham, England, took an interest, so he went there and entered their employ while superintending the making of his machines. While there he began writing upon technical subjects, contributing to *London Engineering*.

His mechanical career in America began in 1864 when he was employed by the firm of Sweet, Barnes & Co., of Syracuse, as draftsman. He was here engaged upon a varied line of machines, one of which was a matrix-impressing machine arranged with a keyboard and aiming to do away with the use of movable type. This machine was really a progenitor of the present linotype machine, and the first and only one constructed was exhibited at the Paris Exposition of 1867 and later presented to Cornell University, where it now is.

In the early seventies Mr. Sweet's efforts were extended in still another field—that of bridge building. At about this time, however, he had conceived the idea of his Straight Line engine which is inseparably connected with his name and is



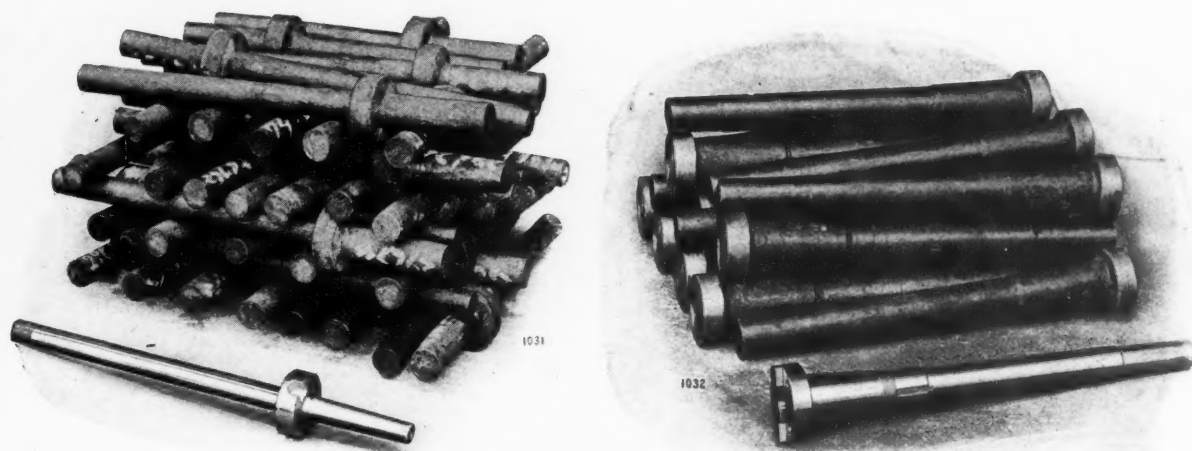
John E. Sweet

perhaps his most characteristic piece of work. The features of the engine are too well known to require extended description. Nearly every feature was different from what had been done before. The straight lines of the frame, the oiling arrangement, the governor, the arrangement and location of the flywheel, the substitution of a plain sleeve for piston rod packing, etc., have been much discussed and have influenced machine design in general.

Prof. Sweet's connection with Cornell University began in 1873 and terminated in 1879. One of the first college machine shops in the country was established at this institution, and Prof. Sweet gave instructions both in shop work and in machine design. The second Straight Line engine built was made by students in this college shop and exhibited at the Centennial Exposition. The Sweet measuring machine was developed while he was at Cornell and was the first machine for accurate measuring made in this country. He introduced into the Sibley shop the making of scraped surface plates and straightedges, and of ground standard gages, at a time when such auxiliaries to shop processes were considered unnecessary refinements. Another of his Cornell products was the Sweet engine lathe, having a cone of change-gears located in the headstock beneath the main cone of the lathe and so connected that any feed or thread could be obtained without putting on or taking off change-gears as in the ordinary type of lathe. Another feature of this lathe was the support of the bed upon three points, a principle that he had adopted, also, in the Straight Line engine frame.

In this period of six years with Cornell University Prof. Sweet arose from a position of comparative obscurity to one of national prominence. Mechanical engineering as a department of organized education was a new thing. There were no precedents and regarding its practicability there was almost universal skepticism. Its plan, its scope, its aims, were unformed even among its friends—and its friends were few. There were no experienced educators. His work was first that of a teacher, and second, that of a pioneer in mechanical construction. In the latter capacity he laid an enduring foundation for interchangeable manufacturing. His experience as a draftsman in England had shown him the fundamental importance of the work of Joseph Whitworth, which heretofore had found little appreciation in America. Combining a keen appreciation of Whitworth's advanced standards of accuracy with original conceptions of correct principles, he established a school of construction, the influence of which was far-reaching. Along with this went an application of art in design—not the art of organization, but the art of perfect adaptation to purpose.

Shortly after his resignation from Sibley College, the Straight Line Engine Co. was organized at Syracuse, with Prof. Sweet as president and manager. In the building and equipment of this plant his originality was manifest, as always. It was one of the first sawtooth roof shops to be erected in this country and among the tools was a planer-type milling machine, then not a common machine in America,



The Spindles and Arbors of Cincinnati Millers are Chrome Nickel Steel

The spindles have an elastic limit of from 90 to 100,000 pounds. On all machines of High Power design, these spindles have flanged ends and drive face mills and arbors through hardened keys. They are not easily injured. The arbors have an elastic limit of from 130 to 150,000 pounds. They are not so likely to spring.

The keys which drive the cutters do not ruin them so easily, and when subjected to accidents they do not readily acquire a permanent "set."

Bunch these facts together and put them down as another reason why your choice should be

A Cincinnati Miller

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

designed by him and built at the Straight Line Engine Co.'s works. The conduct of the plant was unique. A feature of greeting was the sign over the door, "Visitors Always Welcome." Prof. Sweet made it a rule to welcome and entertain the callers who had legitimate interests in mechanical engineering work. His shop contained no secrets and he freely gave advice and counsel to all who sought him.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, was elected its third president and was accorded the honor of presenting the first paper, in recognition of his untiring services during its organization. He was also later elected an honorary member of the society. He was one of the judges on machine tools at the Chicago Exposition; an expert for the government on gun lathes; and one of the founders and first president of the Engine Builders' Association of the United States. He was honored by many societies. In 1914, Syracuse University conferred upon him the degree of doctor of engineering. He was awarded the John Fritz medal in December, 1914, "in recognition of his achievement in machine design and his pioneer work in applying sound engineering principles to the construction and development of the high-speed engine." It was one of the great disappointments of his career that the reciprocating steam engine was displaced by the steam turbine, and the years of thought, research and labor that he had expended had come to naught. He saw many of his engines taken out and thrown into the scrap heap to be replaced by the steam turbine, but he accepted the changes with philosophical cheerfulness. Dr. Sweet was twice married; his first wife, Caroline V. Fulton, died in 1887, and his second, Irene A. Clark, died last year.

COMING EVENTS

June 12-16.—Midsummer cruise of the Society of Automobile Engineers on the Steamship "Noronic," leaving Detroit June 12 and returning June 16. Reservations can be made by application to W. H. Conant, treasurer, 601 Kerr Bldg., Detroit, Mich.

June 14-16.—Annual meeting of the Master Car Builders Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 14-21.—Annual meeting of the Railway Supply Manufacturers Association at Atlantic City, N. J., in connection with the A. R. M. M. and M. C. B. Associations. J. D. Conway, secretary and treasurer, 2136 Oliver Bldg., Pittsburgh, Pa.

June 19-21.—Annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 22-23.—Annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers in Cleveland, Ohio. Frank E. Sanborn, secretary-treasurer, Ohio State University, Columbus, Ohio.

June 27-July 1.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

June 29.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Columbia University, Morningside Heights, New York City. Announcement of the summer session day and evening courses for July 10 to August 18, 1916.

New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass., has issued a business directory for 1916 containing the names and addresses of the members of this society, revised to January 1, 1916.

Stevens Institute of Technology, Hoboken, N. J., introduced report writing as a requirement for graduation about a year ago. The time given to report writing is one afternoon a week during the second half of the senior year. The present senior class is the first to complete this work. The data for these reports are obtained mostly by a search of the literature on the subject. Experimental work is neither required nor encouraged. The subject of the report is chosen by the senior himself during his first term and is submitted for approval to the head of the department in which it falls. The subjects of the reports which have just been submitted by the seniors at Stevens not only cover branches of mechanical, civil and electrical engineering, but also chemistry, civics, economics and welfare work in industrial organizations.

NEW BOOKS AND PAMPHLETS

The Technical Production of Hydrogen and Its Industrial Application. By Harry L. Barnitz. 11 pages, 6 by 9 inches. Published by the author, 617 W. 152nd St., New York City.

The industrial applications of hydrogen have assumed much importance during the past nine or ten years, and this review of the means of producing hydrogen in large quantities at low cost should interest the heads of many industrial works.

Oil Fuel. By Ernest H. Peabody. 34 pages, 6 by 9 inches. 47 illustrations. Paper presented at the International Engineering Congress, San Fran-

cisco, Cal., September, 1915, and reprinted from the Transactions.

The author is an engineer in the marine department of the Babcock & Wilcox Co., New York City, and the subject is treated from the standpoint of the marine engineer. The conditions of oil burning on shipboard are reviewed, and the oil burners and auxiliary apparatus used in oil burning are illustrated and described. Although the paper treats the problem from the marine engineering standpoint, it nevertheless will be of general interest to all concerned with the problem of utilizing oil fuel for steam generation.

Engineering as a Career. Edited by F. H. Newell and C. E. Drayer. 214 pages, 5 by 7 1/4 inches. Published by D. Van Nostrand Co., New York City. Price, bound in cloth, \$1.

This book is intended to be an answer to a father's questions, "What can my boy do as an engineer? What should he learn, or where should he go to school?" It is composed of the following essays: "The Engineer and His Profession," by A. J. Himes; "Shall My Boy Become an Engineer?" by Franklin De R. Furman; "Mechanical Engineering," by Worcester R. Warner; "Railway Engineering," by A. W. Johnston; "Hydraulic Engineering," by Chester W. Larner; "Metallurgical Engineering," by J. H. Herron; "Electrical Engineering," by W. H. Abbott; "Chemical Engineering," by M. C. Whitaker; "Iron and Steel Making," by S. T. Wellman; "Marine Engineering," by J. C. Workman; "Sanitary Engineering," by R. Winthrop Pratt; "Municipal Engineering," by Robert Hoffmann; "Municipal Needs," by Rudolph Blankenburg; "Bridge Engineering," by Frank C. Osborn; "Architecture," by Benjamin S. Hubbell; "Mining," by F. B. Richards; "Opportunities for a Mining Engineer," by Henry S. Munroe; "The Lure of Private Practice," by Ernest McCullough; "Vocational Guidance," by James F. Barker; "Scientific Manufacturing and Its Opportunities," by Waldemar Kaempffert; "Incomes of Technically Trained Men," by David Edgar Rice; "Technical Man in Business," by John Ritchie, Jr.

Mechanical Technology. By G. S. Charnock. 635 pages, 5 1/2 by 8 1/4 inches. 503 illustrations. Published by D. Van Nostrand Co., New York City. Price, \$3 net.

The author has endeavored to bring together in one volume a connected and systematic account of the chief operations underlying mechanical trades. Under the general head of production and properties of the chief materials of construction the work deals with physical properties of materials; cast iron; wrought iron; steel; crucible cast steel; the Bessemer process; the open-hearth or Siemens process; structure of alloys; alloy steels; heat-treatment of steel; non-ferrous metals; copper-zinc alloys; copper-tin alloys; white metal alloys; properties and uses of stone; cement, asbestos, abrasives, etc.; oils; lubricants; leather; india rubber, etc. Under the general head of preparatory processes, the work deals with the production of castings; methods of molding; chilled castings; the foundry; production of steel castings; pouring molten metal; defective castings; foundry mixtures; aids to molding; operations of forging and stamping; forging machinery; classifications of operations in forging; the smith shop; the forges; examples of heavy forging in iron and steel; drop-forging; production of parts by rolling; wire drawing and wire drawing machinery; the production of tubes; manipulation of metals by flanging, etc. The work is comprehensive and should be of much value as a general reference work, particularly to students in technology, mechanical engineering, etc.

Cost Accounting—Theory and Practice. By J. Lee Nicholson. 341 pages, 6 by 9 inches. Illustrated with forms and diagrams. Published by the Ronald Press Co., New York City. Price, \$4.

The author's purpose in writing this book was to provide for the public accountant and cost accountant a reference book dealing in a direct manner with the practical parts of cost accounting; to present the principles and methods of cost accounting in a simple and direct manner; and to furnish the manufacturer with a work containing all the important practical points in connection with cost accounting, summarized and briefly explained. The contents by chapter heads are as follows: Cost Finding and Its Functions; Elements of Costs; Interest in Its Relation to Cost; Principles and General Methods of Cost Finding; Methods of Distributing Indirect Expenses; Wage Systems; Recording the Material and Labor Costs; Compiling the Cost Data; Control of the Cost Records by the Financial Records; The Examination of a Plant; Devising a Cost System; Estimating Cost Systems; Departmental Systems; Special Order System Based on the Productive Labor Method; Special Order System Based on the Process or Machine Method; Prod-

uct System on the Productive Labor Method; Product System Based on the Machine or Process Method; Forms Relating to Material; Production Orders and Requisitions; Time Reports and Pay-roll Forms; Summaries of Production and Cost; Forms Relating to Finished Product, Sales and Financial Records. The work is one that we believe will be found useful by many manufacturers and plant managers who have experienced difficulties in devising and operating efficient and simple cost accounting systems in their plants.

English and American Tool Builders. By Joseph Wickham Roe. 315 pages, 6 by 9 inches. 57 illustrations. Published by the Yale University Press, New Haven, Conn. Price, \$3.

This historical work is timely and interesting. The early books such as Smiles' "Industrial Biography" are out of print, and no one had adequately covered the development of the machine tool building industry since these early works were published. The author says in his preface: "The purpose of this book is to bring out the importance of the work and influence of the great tool builders. Few realize that their art is fundamental to all modern industrial arts. Without machine tools, modern machinery could not be built. Little is known by the general public as to who the great tool builders were, and less is known of their lives and works." It surely is commendable to bring before the public knowledge of machine tools and the parts they play in the industrial world. Many able men display almost total ignorance of the fundamentals of manufacture—the means by which machinery is produced. The work contains twenty chapters with two appendices and a partial bibliography on tool building. Chapter heads in order are as follows: Influence of the Early Tool Builders; Wilkinson and Bramah; Bentham and Brunel; Henry Maudslay; Inventors of the Planer; Gearing and Millwork; Fairbairn and Bodmer; James Nasmyth; Whitworth; Early American Mechanics; The Rise of Interchangeable Manufacture; Whitney and North; The Colt Armory; The Colt Workman—Pratt & Whitney; Robbins & Lawrence; Brown & Sharpe Mfg. Co.; Central New England; The Naugatuck Valley; Philadelphia; The Western Tool Builders. The book gives every evidence of careful preparation and is replete with references to sources of information. It should have a place in the library of every mechanical engineer who is interested in any way in the means of manufacture—and what mechanical engineer is not?

NEW CATALOGUES AND CIRCULARS

Edwin E. Bartlett, 326 A St., Boston, Mass. Catalogue of Greenleaf arbor presses.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Circular advertising the "Lea" V-notch recording liquid meter.

Young, Corley & Dolan, Inc., 149 Broadway, New York City. Circular of the "Sterling" 18 by 50 inch, plain, universal or crankshaft grinders with hand or power table feed.

National Engineering & Tool Works, Oak Park, Ill. Circular of the "Neat" high-power fourteen-inch tool-room and manufacturing lathe, with three-step cone and double back-gears.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 11, illustrating the side-squeezing and gripping power of the new type National heavy-pattern forging machines.

National Forge & Tool Co., Erie, Pa. Catalogue descriptive of manufacturing tool-holders for heavy work, and hollow bored forgings, including clamp blocks, planer bolts, U-clamps, spindles, etc.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Bulletin 182, describing pneumatic stone tools, stone dressers, air compressors, and equipment for stone yards and monumental work.

Stow Mfg. Co., Binghamton, N. Y. Booklet entitled "Portable Tools of Proven Value," illustrating portable electric tools, motor-shaft combinations and flexible shafts of all sizes from 1/4 inch up.

Roth Brothers & Co., Adams and Loomis Sts., Chicago, Ill. Bulletin 212 describing Types C and IX alternating-current motors, which are designed to meet the requirements of low operating and low maintenance cost.

Wallace Barnes Co., South and Parallel Sts., Bristol, Conn. Table of decimal equivalents of fractions from 1/64 to 63/64 inch, varying by sixty-fourths of an inch, mounted on heavy cardboard for convenient reference.

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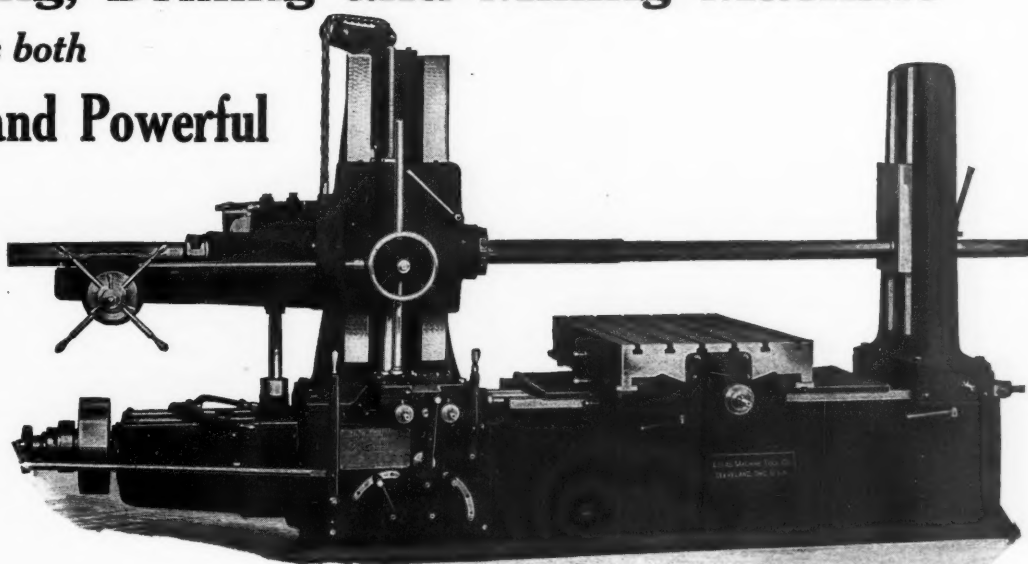
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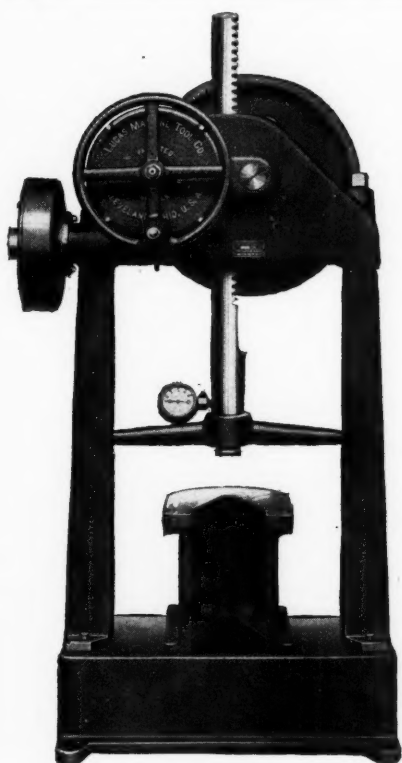
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CLEVELAND, O., U.S.A.

A. & F. Brown Co., 79 Barclay St., New York City. General catalogue 100, of shafting, pulleys, hangers, couplings, pillow-blocks, belt tighteners, and other transmission equipment, containing 129 pages, 5 by 8 inches.

T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City. Circular of the simplex emery band grinder and the duplex emery band and disk grinder for finishing parts that require straight-grain finishes with emery cloth.

Vanadium-Alloys Steel Co., Pittsburg, Pa., has ready for distribution a new folder which describes "Red Cut Superior" high-speed steel, and contains suggestions concerning heat-treatment. A copy will be mailed free upon request.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Bulletin E-39, superseding E-36, illustrating and describing "Duntley" heavy-duty portable electric grinders and electric precision grinders for external and internal grinding.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Bulletin treating of worm, spiral and helical gears, giving information as to the relative advantages of these types of drives and the conditions for which each is particularly adapted.

Acme Machinery Co., Cleveland, Ohio. Pamphlet entitled "A Message to the Superintendent and Tool-room Foreman," which illustrates and describes the Acme die grinder and Acme dies with standard die-caps. The correct way to grind a threading die is also shown.

A. G. Butler, Inc., Postal Telegraph Bldg., 253 Broadway, New York City. Leaflet of pattern letters and figures made of white metal and brass for the use of patternmakers, foundrymen, etc., in lettering and numbering patterns for castings. A table of sizes and prices is included.

Crowe Name Plate & Engraving Co., 1749 Grace St., Chicago, Ill. Catalogue illustrating various styles of nameplates, metal labels, signs, tablets and patterns, etc., manufactured by this firm. These plates are made with either sunken or raised letters. Prices and sizes are included.

New Departure Mfg. Co., Bristol, Conn. Leaflets for looseleaf catalogue, Nos. 63FE, 64FE, 65FE and 66FE, descriptive of typical two-bearing mountings, change-speed gearing for machine tools, ball bearing grinding spindles, and ball bearing attrition mill; also table of contents for FE edition.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-Q, entitled "A Few Applications of 'Giant' Gas and Fuel Oil Engines." The bulletin shows applications to a vertical triplex pump, horizontal duplex pump, direct-current generator, volume exhauster, fans, hoists, portable air compressors, etc.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 10 gives some facts about forging machine bed frames and illustrates the underslung steel bed frame of the National heavy-pattern forging machine, which is heavily ribbed and webbed in order to give the greatest strength and rigidity.

C & C Electric & Mfg. Co., Garwood, N. J. Bulletin 101 of Type SL motors of the four-pole, interpole type, built in sizes from 1 to 125 horsepower. The bulletin illustrates and describes the details of construction of the parts and contains a complete table of adjustable and constant-speed ratings, with full dimensions of all frames.

Ross Heater & Mfg. Co., Buffalo, N. Y. Catalogue A, describing and illustrating the Ross cross-head-guided expansion joint, for high- and low-pressure steam, oil, gas, and water piping. It is claimed that by the use of a crosshead-guided expansion joint, the pipe lines are kept absolutely free from stress both when hot and when cold.

Cincinnati Planer Co., Cincinnati, Ohio. Pamphlet entitled "The History of the Planer" which traces the history of the planer, step by step, from the earliest design (1751) to the highly developed machine of today. The book contains many illustrations showing the early types of planers compared with the modern Cincinnati planing machines.

Searchlight Co., 1016 Karpen Bldg., Chicago, Ill. Circular on dry vs. wet acetylene, telling why it takes more time and costs more money to make a poor weld with wet acetylene than it does to make a good weld with dry acetylene. The company sells compressed acetylene in cylinders, the cylinders containing 100 cubic feet of free acetylene gas, free from water.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 9023, treating of "Imperial" tie tamping outfits. Form 3026, devoted to Ingersoll-Rogier Class PRE duplex direct-connected, electrically driven air compressors. Pressure charts and tables are given, showing the sizes and capacities of these compressors. Form 3312 of "Imperial XB" duplex power-driven air compressors.

Herman A. Holz, 50 Church St., New York City. Catalogue descriptive of the new type of Brinell portable meter for accurately and conveniently determining the hardness of metal and metal products. This meter is adapted for testing the hardness of metals of any dimensions or shape and in any location. The total weight is 6½ pounds, and it can be carried in a 6 by 9 inch case.

C & C Electric & Mfg. Co., Garwood, N. J. Bulletin 102-X of Type IB motors with commutating poles. These new motors are furnished in ratings up to ten horsepower. They are of the bipolar type, and are built in the open, semi-closed and totally enclosed forms. They are especially suited for direct connection to machine tools, fans and general industrial machinery.

Sprague Electric Works of the General Electric Co., 527 W. 34th St., New York City. Bulletin

48706 of alternating-current, two- and three-phase motors and controllers for flat-bed and small rotary printing presses. Bulletin 48907 descriptive of 500-pound electric hoists, Type I-5. Bulletin 49600 describing flexible steel armored conductors; flexible steel conduit; stamped steel boxes; and fittings and tools.

Wallace Barnes Co., South and Parallel Sts., Bristol, Conn. Booklet 7, treating of Barnes springs, screw machine products, cold-rolled steel and wire, washers, and stampings. The book contains a number of valuable tables, among which are: table for determining capacities of round wire helical springs; decimal equivalent table; table of standard gages used in the United States; tables indicating size, weight and length of wire, and weight per foot of cold-drawn steel, etc.

Machinery, 140-148 Lafayette St., New York City. Booklet of "Safety Don'ts," containing don'ts for machine operators in general, don'ts for lathe operators, don'ts for drill press operators, don'ts for planer and shaper operators, don'ts for milling machine operators, don'ts for slotter operators, don'ts for boring mill operators, don'ts for grinding machine operators, don'ts for gear hobbers, don'ts for screw machine operators, general machine shop don'ts, don'ts for electricians, belting don'ts, don'ts for crane and hoist operators, don'ts for foremen. Sent free on application.

R. G. Haskins, 541 W. Washington Blvd., Chicago, Ill. Catalogue 10 of "Strand" flexible shafts, portable grinders equipped with flexible shafts, motor-driven toolpost equipment and countershaft equipment. The "Strand" flexible shafts are adapted for external and internal grinding of dies in lathe and shaper, truing lathe centers, and grinding flat gages in shaper; sharpening punches in press without disturbing setting; grinding heavy castings, fins on gears and pulleys; cleaning castings with wire scratch brush; waxing furniture for stencil work; sanding the arms of chairs and removing paint; drilling in metal and boring in wood.

Richardson-Phenix Co., Milwaukee, Wis. Bulletin 5 describing a line of filters for purifying lubricating oil, having capacities of from 25 gallons a day to 50,000 gallons an hour. Some large-size filters for use in purifying lubricating oil from water wheel thrust bearings, large gas and steam engines in steel mills, and also for purifying cutting lubricants are illustrated and described. An idea of the size of the largest filters made may be gained from the fact that the oil connections into some of them are of ten-inch pipe. The catalogue serves to indicate the remarkable advance made in recent years in the science of oil filtration, and it shows how scientific principles are employed in the small as well as in the large filters.

Buffalo Forge Co., Buffalo, N. Y. Bulletin of hand and power punches and shears, showing a line of punches, shears and bar cutters for special work. Reinforced concrete construction has created a demand for powerful hand tools for cutting round, square and twisted bars, and for bending these and structural shapes. The catalogue not only shows these tools but also includes continuous slitting shears, angle-iron cutters that will not distort or flatten the metal, beam punches for channels, T-sections and I-beams; also a variety of power machines for heavier work, all of which are of armor-plate construction, lighter and stronger than cast iron. The new fan erecting shop which the company has just completed contains about 500 tons of structural steel, all of which was fabricated on the premises, using machines of the company's own make.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin entitled "The Potentiometer System of Pyrometry," describing the pyrometer based on the use of the thermocouple but differing from the ordinary deflection galvanometer or millivoltmeter pyrometer in that the electromotive force resulting from the difference in temperature between the hot and cold ends is measured by a balancing method rather than by deflection of a needle. Thus, a variable but always known electromotive force is connected into the circuit with voltage opposing that of the couple. A galvanometer is also introduced into the circuit to show when the two voltages are equal, since at this time the pointer will stand at zero. This produces a pyrometer independent of the immersion and resistance of the thermocouple and of the temperature and length of the connecting leads and of the resistance and calibration of the galvanometer itself.

Graton & Knight Mfg. Co., Worcester, Mass. Catalogue 6 illustrating and describing the products made by this company, which include leather, leather belting, lace leather, belt cement, belt dressings, leather packings, strapping, automobile leathers, etc. This book also contains much matter of general interest to those who purchase belting, lace leather, packings and other leather products. The belting section is of unusual interest to buyers of belting, as it describes the characteristic qualities of each grade manufactured and explains why these grades are essential, their differences and capabilities. This section also embodies valuable mechanical rules, tables and formulas to further assist the buyer in determining the proper grade, width and weight of belting for any given drive. Another section of the catalogue is devoted to leather packings, describing all the various kinds, grades and advantages of each. A copy of the catalogue will be sent upon request to executives, purchasing agents, managers, superintendents, mechanical engineers and others interested in the buying of belting and other leather products.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. General catalogue of Besly fine tools, machinists', mill and railroad supplies, brass, copper, bronze and German silver, brass wire cloth, disk grinders, helmet taps, etc.; 771 pages, 6½

by 9 inches. An idea of the extent of this catalogue will be gained from the fact that the general index covers twenty-two pages. The first section is devoted to brass and the following sections to small tools ordinarily used in the machine shop, arranged in the sequence of their use, namely, drills, reamers, taps, dies, etc. The index or finding list not only contains the manufacturers' names and numbers of the various tools illustrated and described, but also indexes the tools under the common shop nomenclature. Each section of the catalogue is complete and contains tables of information relating to the particular tools illustrated in that section. Thus it is possible to withdraw any section and bind it in a separate binder. For example, the grinder section is issued separately as a condensed grinder catalogue, and this plan can also be followed, when desired, with the brass, drill, tap or any other section. The convenience of this feature is obvious.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Book treating of "Nonpareil" high-pressure covering for high-pressure and superheated steam lines, boilers, breechings, feed-water heaters, tanks, and other heated surfaces. Nonpareil high-pressure covering is composed of diatomaceous earth and asbestos fiber. The former substance is practically pure silica. It is claimed that this covering is a good non-conductor of heat, able to withstand relatively high temperatures without calcining, and is unaffected by moisture, thus making a very efficient material for heat insulation purposes. The book comprises a treatise on the subject of heat insulation, giving the results of tests. Particular attention is called to the comparative tests made at the Beaver Falls factory, which are described on pages 7 to 21. As a result of these tests, it has been possible to fix definitely the heat losses from various sizes of covered and uncovered pipe. These losses are given in B. T. U. per lineal foot, per degree difference in temperature for twenty-four hours, and are tabulated on pages 41 and 42. Tables are also given showing the most economical thicknesses of "Nonpareil" high-pressure covering to use, based on different steam costs, and a complete set of specifications covering the correct installation of these various thicknesses of covering is included. Anyone interested in the insulation of high-pressure and superheated steam lines will find this book of value, and can obtain a copy upon application to the company.

TRADE NOTES

Sibley Machine Tool Co., 8 Tutt St., South Bend, Ind., has changed its name to Sibley Machine Co.

Tropenas Converter Co. has removed its city office from 50 Church St., New York City, to 2243 Nostrand Ave., Brooklyn, N. Y.

Winter Bros. Co., Wrentham, Mass., is building a brick addition to its plant, 125 by 40 feet, to provide facilities for the increased business.

George P. Clark Co., Windsor Locks, Conn., manufacturer of shop trucks, has changed its New York office from 21 Park Row to 116 Nassau St., suite 601.

W. D. Molin & Co., Reading, Pa., manufacturers of machine vises, are increasing their plant facilities by the purchase of a three-story brick building near the present plant.

James Clark, Jr., Electric Co., Louisville, Ky., manufacturer of portable electric drills and grinders, has removed its Chicago office from Machinery Hall to 31 N. Jefferson St.

Atlas Machine Co., Providence, R. I., has removed from 110 W. Exchange St. to the Enterprise Bldg., 7 Eddy St., where a more complete equipment has been provided to increase the manufacturing facilities.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., maker of electric furnaces, pyrometers and heating appliances, opened a branch office at 613 Unity Bldg., 185 Devonshire St., Boston, Mass., in charge of J. E. Hines.

Zeh & Hahnemann Co., Avenue A and Vanderpool St., Newark, N. J., has completed an addition to its plant that will increase the capacity about 25 per cent. The addition will be used as an erecting room and the new office.

Norma Co. of America, 1790 Broadway, New York City, at its annual meeting elected W. M. Nones president and treasurer. Mr. Nones was formerly secretary-treasurer and general manager of the company, and he will continue to fill the position of general manager.

United Motors Corporation is a \$80,000,000 company formed to merge the Perlman Rim Corporation of Jackson, Mich., the New Departure Mfg. Co. of Bristol, Conn., the Hyatt Roller Bearing Co. of Newark, N. J., the Delco Co. of Toledo, Ohio, and the Remy Co. of Indianapolis, Ind.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, has acquired all the property, assets and business of the International Steam Pump Co. and its various subsidiaries except the Henry R. Worthington Works, of which it holds most of the capital stock.

Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill., manufacturer of "Thor" air and electric drills, pneumatic riveting, chipping, calking and flue beading hammers, has moved its Georgia branch headquarters to Birmingham, Ala. A suite of offices has been leased in the Jefferson County Bank Bldg.

Goddard Tool Co., 341-351 W. Chicago Ave., Chicago, Ill., has been incorporated under the laws of Illinois with \$500,000 capital stock, for the manufacture of milling cutters, hobs and special tool work. Paul B. Goddard, formerly with the Illinois Tool Works, is the general manager.

